Tariff Rates, Tariff Revenue, and Tariff Reform: Some New Facts
Lant Pritchett and Geeta Sethi

The Effect of Financial Liberalization on the Capital Structure and Investment Decisions of Indonesian Manufacturing Establishments
John R. Harris, Fabio Schiantarelli, and Miranda G. Siregar

The Scope for Fuel Substitution in Manufacturing Industries: A Case Study of Chile and Colombia
Diana L. Moss and James R. Tybout

How Robust Is a Poverty Profile?
Martin Ravallion and Benu Bidani

The Impact of Two-Tier Producer and Consumer Food Pricing in India
Maurice Schiff

Domestic Content and Compensatory Export Requirements: Protection of the Motor Vehicle Industry in the Philippines
Wendy E. Takacs
The World Bank Economic Review is a professional journal for the dissemination of World Bank-sponsored research that informs policy analyses and choices. It is directed to an international readership among economists and social scientists in government, business, and international agencies, as well as in universities and development research institutions. The Review emphasizes policy relevance and operational aspects of economics, rather than primarily theoretical and methodological issues. It is intended for readers familiar with economic theory and analysis but not necessarily proficient in advanced mathematical or econometric techniques. Articles will illustrate how professional research can shed light on policy choices. Inconsistency with Bank policy will not be grounds for rejection of an article.

Articles will be drawn primarily from work conducted by World Bank staff and consultants. Before being accepted for publication by the Editorial Board, all articles are reviewed by two referees who are not members of the Bank’s staff; articles must also be recommended by at least one external member of the Editorial Board.

The Review may on occasion publish articles on specified topics by non-Bank contributors. Any reader interested in preparing such an article is invited to submit a proposal of not more than two pages in length to the Editor.

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

Comments or brief notes responding to Review articles are welcome and will be considered for publication to the extent that space permits. Please direct all editorial correspondence to the Editor, The World Bank Economic Review, The World Bank, Washington, D.C. 20433, U.S.A.

The World Bank Economic Review is published three times a year (January, May, and September) by the World Bank. Single copies may be purchased at $10.95. Subscription rates are as follows:

<table>
<thead>
<tr>
<th></th>
<th>Individuals</th>
<th>Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-year</td>
<td>US$25</td>
<td>US$45</td>
</tr>
<tr>
<td>2-year</td>
<td>US$46</td>
<td>US$86</td>
</tr>
<tr>
<td>3-year</td>
<td>US$65</td>
<td>US$125</td>
</tr>
</tbody>
</table>

Orders should be sent to: World Bank Publications, Box 7247–7956, Philadelphia, PA 19170–7956 U.S.A. Subscriptions are available without charge to readers with mailing addresses in developing countries and in socialist economies in transition. Written request is required every two years to renew such subscriptions.

© 1994 The International Bank for Reconstruction and Development / THE WORLD BANK
All rights reserved
Manufactured in the United States of America
ISSN 0258-6770

Material in this journal is copyrighted. The World Bank encourages dissemination of its work and will normally give permission promptly and, when the intended reproduction is for noncommercial purposes, without asking a fee. Permission to make photocopies is granted through the Copyright Clearance Center, 27 Congress Street, Salem, MA 01970 U.S.A.

This journal is indexed regularly in Current Contents/Social & Behavioral Sciences, Index to International Statistics, Journal of Economic Literature, Public Affairs Information Service, and Social Sciences Citation Index®. It is available in microform through University Microfilms, Inc., 300 North Zeeb Road, Ann Arbor, Michigan 48106, U.S.A.
THE WORLD BANK ECONOMIC REVIEW

Volume 8  January 1994  Number 1

Tariff Rates, Tariff Revenue, and Tariff Reform: Some New Facts
Lant Pritchett and Geeta Sethi

The Effect of Financial Liberalization on the Capital Structure and Investment Decisions of Indonesian Manufacturing Establishments
John R. Harris, Fabio Schiantarelli, and Miranda G. Siregar

The Scope for Fuel Substitution in Manufacturing Industries: A Case Study of Chile and Colombia
Diana L. Moss and James R. Tybout

How Robust Is a Poverty Profile?
Martin Ravallion and Benu Bidani

The Impact of Two-Tier Producer and Consumer Food Pricing in India
Maurice Schiff

Domestic Content and Compensatory Export Requirements: Protection of the Motor Vehicle Industry in the Philippines
Wendy E. Takacs
Tariff Rates, Tariff Revenue, and Tariff Reform: Some New Facts

Lant Pritchett and Geeta Sethi

This article compares the statutory ad valorem tariff rates (official rates) with the ratio of tariff revenues to import values (collected rates) for Jamaica, Kenya, and Pakistan. It identifies four general features of the tariff codes, considers whether these features apply to all developing countries, and discusses four implications of these features for tariff reform. First, the collected rate for any given item in the tariff code is only weakly related to the official rate for that item. Second, the variation of collected rates around the official rate increases with the level of the official rate. Third, the collected rates, on average, increase much less than the official rates. Fourth, the relation between official rates and collected rates is nonlinear, because the slope is lower at higher levels of the official rate.

Trade policy reforms in developing countries typically include tariff reforms that aim to rationalize the tariff code, reduce the dispersion of tariff rates, and lower average tariffs. However, because many tariff reforms are undertaken during periods of stabilization and fiscal austerity, the potential loss of tax revenues from lowering tariff rates is commonly perceived to be an important constraint on tariff reform (Rajaram 1992; Mitra 1992). The relation between tariff rates and tariff reform is therefore of considerable interest.

This article uses data from three developing countries—Jamaica, Kenya, and Pakistan—on items in the tariff code to examine the relation between tariff revenues and tariff rates. For each item, we calculate the ratio of import tax revenues to import value, or the "collected rate" of tariffs. Comparing these collected rates to the official, statutory rates of the tariff code, we demonstrate four facts about the relation between tariff rates and tariff revenues.

1. Collected and official tariff rates are only weakly related. In prereform countries, differences in official tariff rates across items explain only about a quarter of the variation in collected rates.

1. The words "official" or "statutory" rate of tariff are used interchangeably to mean the ad valorem rate recorded as "the" rate for each item in the tariff code. Of course, often the same item may have different rates specified, with exemptions granted (or charges added), depending on the country of origin, importing industry, or end use. For simplicity, we refer to these as exemptions from the "official" rate, even though these exemptions are legally as much part of the tariff regime as are the "official" rates.

Lant Pritchett is with the Policy Research Department at the World Bank; Geeta Sethi is with the Policy Research Department and the University of Maryland.

© 1994 The International Bank for Reconstruction and Development / THE WORLD BANK
- The variance of collected rates increases strongly with the level of the official rate.
- The collected rate increases much less than one-for-one with increases in the official rate.
- When the official tariff rate is high, the rate at which collected rates increase as official rates increase falls. We also find weak evidence that, beyond a limit, further increases in the official tariff rate produce no increase (and perhaps a decrease) in the collected rate.

A convenient way to frame the four facts is with the following relation for the ith item in the tariff code:

\[ \text{Collected rate}_i = \alpha + \beta (\text{Official rate}_i) + \epsilon_i. \]

If all importers actually paid the import duty at the official rate, then the explanatory power of this relation would be high; the slope, \( \beta \), would be one, and the relation would be linear. But our research shows otherwise: the explanatory power of equation 1 is low, \( \beta \) is much less than one, and the relation is not linear. In addition, the error term, \( \epsilon_i \), does not have a constant variance, so the dispersion of collected rates rises with official rates.

We argue that the evidence from our research represents general features of prereform tariff codes in developing countries, with two immediate implications. First, in reforming the system of tariffs and tariff revenue collection, the change in official rates of tariff, especially at the high levels, is likely not the most important element of reform affecting revenue. Changes in procedures for assessing import value, granting exemptions, and collecting the revenue are likely to be more important. Second, simulations that assume that tariff revenues fall one-for-one with rates (such as those supported by the World Bank's SINTIA software) overstate the impact of rate reductions on revenues by assuming constant collection rates. Determining the impact of tariff reductions on revenue requires careful assessment of the exemption status of imports.

This article has six sections and a conclusion. The first section describes the data and the tariff regimes in Jamaica, Kenya, and Pakistan, the countries for which tariff line-level data on tariff rates, import values, and import duty collected. Table 1 summarizes the evidence for each of the four stylized facts listed above. The sixth section discusses evidence from other countries suggesting these four features are general to prereform tariff regimes in developing countries. The conclusion summarizes and discusses the implications for the analysis of the relation between revenues and tariff reform.

I. Tariff Regimes and Data on Tariffs, Collections, and Import Values

As part of ongoing research on tariff reform, we have collected data on tariffs at the tariff code item level for a large number of countries (Pritchett and Sethi 1993). For three of these countries—Jamaica, Kenya, and Pakistan—we have official rates of duty, import values, and import duty collected. Table 1 summa-
Table 1. Characteristics of the Tariff Code in Jamaica, Kenya, and Pakistan

<table>
<thead>
<tr>
<th>Country (year)</th>
<th>Number of tariff items with imports</th>
<th>Number of official rates</th>
<th>Average tariff rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Official collected</td>
</tr>
<tr>
<td>Jamaica (1991)</td>
<td>3,303</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Kenya (1987)</td>
<td>3,392</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Pakistan (1991)</td>
<td>4,317</td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32</td>
</tr>
</tbody>
</table>

a. The average of the official rates is import weighted.

Source: World Bank data.

rizes some characteristics of the tariff code for these three countries. The second column gives the number of separate items distinguished in the countries' tariff nomenclature. These countries' tariff codes are moderately detailed and distinguish between 3,000 and 5,000 items.

The second column indicates the total number of rates of import duty for each country. In addition to import duty, various fees (for example, customs-processing fees) and additional taxes (for example, excise, sales, or luxury taxes) may be levied and collected on imports at the port of entry. We focus only on import duties, because the other components either are small, do not vary across items, or are not, strictly speaking, import taxes. Our revenue collection numbers correspond as closely as possible to these import duties. For Jamaica, import revenue is from the common external tariff. For both Kenya and Pakistan, the revenues are based on collection from just the import customs duty.

The last two columns present the average statutory tariff rate (weighted by import value) and the average collected rate. (Tariff code items with zero import value were excluded from all calculations, because the collected rate could not be constructed.) The import-weighted tariff rate gives a hypothetical revenue: the revenue from the tariff code if all import taxes were collected at the official rate. As with other countries, actual revenues are below this hypothetical level. Both duty revenues and import values are taken directly from customs statistics. Therefore, tariff revenue losses in relation to the true level of imports are not captured because of smuggling, underdeclaration of import values (underinvoicing), and misdeclaration of items with high rates. To the extent these are important, we understate the gap between actual revenues and those that would be collected if all imports were correctly reported and paid at the official tariff. The differences we examine are entirely caused by differences from the tariff code recorded in customs statistics.

The data reflect different stages in the countries' trade reforms. Jamaica had already had several rounds of tariff reform, with substantial reductions in the average rate. Pakistan's tariff code had already undergone substantial rationalization as part of the country's adjustment efforts. Kenya's trade reform mainly focused on import licensing to date, including some tariffication that raised the unweighted average.
II. Collected Rates and Statutory Rates: Not Even Cousins

One might suppose that if different items in the tariff code had the same tariff rate, the collected rate for those items would be, if not identical, at least similar. That is not the case. The influence of official rates on collected rates across tariff line items is quite weak. For selected levels of the official tariff rate, table 2 presents the number of items at that rate, the average collected rate, the standard deviation (and coefficient of variation), and the lowest 25th and 75th percentiles of the collected rates. The table gives a heuristic preview of a number of the results to be presented statistically.

An interesting feature is the huge variation in collected rates for items with the same official rate. For example, in Pakistan the mean collected rate for the 899 items with a tariff rate of 80 percent is 51 percent, but the standard deviation is 31. For the lowest one-quarter of the items at the 80 percent official rate, the mean collected rate was less than 21 percent; for the highest one-quarter, it was above 78 percent. At the 20 percent official tariff level, the mean collected rate on the lowest 75 percent was 20, indicating that many items paid the full rate. At the 80 percent official rate, the mean collected rate on the lowest 25 percent was 21 percent. Thus, the actual rate paid for a significant portion of items in the 80 percent official tariff category was the same as that at the 20 percent

Table 2. Summary Statistics of Collected Rates by Level of Official Rate in Jamaica, Kenya, and Pakistan

<table>
<thead>
<tr>
<th>Country, year, and official rate (percent)</th>
<th>Number of items</th>
<th>Mean collected rate (percent)</th>
<th>Standard deviation(^a)</th>
<th>25th percentile</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jamaica (1991)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1,375</td>
<td>7</td>
<td>7 (91)</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>30</td>
<td>517</td>
<td>16</td>
<td>12 (76)</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>45</td>
<td>662</td>
<td>24</td>
<td>17 (72)</td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td>Kenya (1987)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>331</td>
<td>5</td>
<td>10 (194)</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>950</td>
<td>9</td>
<td>14 (156)</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>40</td>
<td>435</td>
<td>20</td>
<td>20 (101)</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>50</td>
<td>429</td>
<td>26</td>
<td>27 (106)</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>60</td>
<td>206</td>
<td>43</td>
<td>39 (92)</td>
<td>26</td>
<td>56</td>
</tr>
<tr>
<td>80</td>
<td>306</td>
<td>31</td>
<td>30 (95)</td>
<td>26</td>
<td>31</td>
</tr>
<tr>
<td>100</td>
<td>108</td>
<td>36</td>
<td>37 (102)</td>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>Pakistan (1991)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>547</td>
<td>15</td>
<td>14 (92)</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>789</td>
<td>32</td>
<td>18 (56)</td>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>60</td>
<td>267</td>
<td>40</td>
<td>21 (53)</td>
<td>23</td>
<td>58</td>
</tr>
<tr>
<td>80</td>
<td>899</td>
<td>51</td>
<td>31 (61)</td>
<td>21</td>
<td>78</td>
</tr>
<tr>
<td>100</td>
<td>495</td>
<td>52</td>
<td>40 (76)</td>
<td>7</td>
<td>94</td>
</tr>
<tr>
<td>125</td>
<td>605</td>
<td>54</td>
<td>47 (88)</td>
<td>3</td>
<td>95</td>
</tr>
</tbody>
</table>

\(^a\) Coefficients of variation are in parentheses.

Source: World Bank data.
Table 3. *Estimation Results for Tests of the Explanatory Power of Official Rates for Collected Rates*

<table>
<thead>
<tr>
<th>Statistic and functional form</th>
<th>Jamaica</th>
<th>Kenya</th>
<th>Pakistan</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANOVA</td>
<td>0.31</td>
<td>0.27</td>
<td>0.23</td>
</tr>
<tr>
<td>$R^2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>0.29</td>
<td>0.21</td>
<td>0.16</td>
</tr>
<tr>
<td>Log-log</td>
<td>0.30</td>
<td>0.24</td>
<td>0.18</td>
</tr>
<tr>
<td>Linear with spline</td>
<td>0.29</td>
<td>0.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Quadratic</td>
<td>0.29</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>Sample size (N)</td>
<td>3,002</td>
<td>3,392</td>
<td>4,317</td>
</tr>
</tbody>
</table>

Note: All results are statistically significant in the sense that they allow a rejection of the hypothesis of no relationship. Functional forms of regressions of the collected rate (CR) on the official rate (OR) are as follows: linear, $CR = \alpha + \beta OR$; log-log, $\ln(CR) = \alpha + \beta \ln(OR)$; linear with spline, $CR = \alpha + \beta OR + \beta_1(OR - t^*)$, where $t^*$ is the level of official tariff at which the slope changes; and quadratic, $CR = \alpha + \beta OR + \beta_1 OR^2$. The full regression results for these forms are presented in tables 5 and 6.

Official rates. Similarly, of the 495 items with a 100 percent tariff, for a quarter collected rates were less than 7 percent and for a quarter collected rates were more than 94 percent. The distribution of collected rates for items with 100 percent tariff is more or less even between 0 and 100 percent. This is also true for Kenya. Among the 429 items with a tariff rate of 50 percent, the mean collected rate is only 26 percent, for a quarter collected rates were less than 6 percent, for a quarter collected rates were more than 26 percent, and the standard deviation is 27.

The large variation in collected rates, even for items with the same official rate, suggests that there is little systematic relation between the official tariffs item by item and actual collected rates. Table 3 illustrates this statistically. An analysis of variance (ANOVA) decomposed the variation of the collected rates of individual items into the component associated with variations in official rates and the component of the variation in collected rates for items with the same official rate. The percentage of the variance in collected rates that is explained by official rates is 31 for Jamaica (even after several rounds of tariff reform), 27 for Kenya, and 23 for Pakistan. Typically about a quarter of the variation of the tariff revenues collected across products is related to variations in the official rates for those products. Although one-quarter is significantly different from zero, it is even more emphatically different from one. This low explanatory power is especially surprising, given the enormous variation in the official rates.

An alternative procedure is to assume some functional relation between the collected rate and the official rate of the form

$$Collected \ rate^i = f(Official \ rate^i) + \epsilon^i.$$  \[2.\]  

If the collected rate were primarily a function of the tariff rate, one would expect...
a relation of this type to have high explanatory power. The second to fifth rows of table 3 report the $R^2$ of a regression of collected rates on statutory rates for a variety of functional forms.\textsuperscript{3} The $R^2$ values are very low, confirming the results of the ANOVA.\textsuperscript{4} For Kenya and Pakistan the $R^2$ is uniformly below 25 percent, while for Jamaica it is roughly 30 percent. A low $R^2$ uniformly across the various functional forms reveals that little of the variation in collections is related to variations in official rates.

III. INCREASING VARIATION OF THE COLLECTED RATE

The variation of the collected rate of items with the same official rate increases as the official rate rises. In table 2 we see that for each country the standard deviation increases substantially with the level of the rate. For instance, in Kenya, the standard deviation is 10 when the tariff is 20 percent, and it increases to 20 at 40 percent and to 39 at 60 percent.

Of course, the standard deviation is not scale invariant, so the increasing variance, although interesting, is not altogether surprising. The coefficient of variation (in parentheses in column 4 of table 2) divides the standard deviation by the mean to achieve a scale-invariant number. The results here are more ambiguous. For Pakistan the coefficient of variation indicates that not only do higher statutory rates have higher absolute deviations, but, except for the lowest rates, they are generally larger as a fraction of the mean value as well. But this is not true of Jamaica or Kenya.

Table 4 reports statistical tests of increasing variance in several forms. The first row contains the results of an ANOVA with the levels of the official rate as the treatment variable and the variance of collected rates within items with that official rate as the dependent variable (as opposed to the level of collected rates in table 3). We find that the level of the official tariff is at least as successful in explaining the variation of collected rates around the official rate as it was in explaining the average of collection rates. The ANOVA values, the “fraction explained,” of 0.42 and 0.41, for Jamaica and Pakistan, respectively, are substantially higher than those in table 3. In a sense, we can predict with more confidence the effect of increasing the tariff on the variance than on the mean of collections. In the following rows, the absolute value (or squares) of the residuals of the collected rate regressed on the statutory level of the tariff are themselves regressed on the level of the statutory rate.\textsuperscript{5} The explanatory power of the log-log specification shows that the percentage variation of the residual increases with the absolute level of the official rate (although all of these relations are weaker for Kenya).

\textsuperscript{3} These regressions are reported fully below in table 5.

\textsuperscript{4} Because the regression formulations impose additional structural restrictions on the relation, the $R^2$ will actually be lower than the ANOVA.

\textsuperscript{5} Although this is essentially a test of heteroskedasticity of the error term in the levels of regressions, this is not interesting as a regression error term, but rather as the variation of the conditional mean of collected rates.
Table 4. Estimation Results of Regressions of the Variance of the Collected Rate and the Level of the Official Tariff

<table>
<thead>
<tr>
<th>Statistic and functional form</th>
<th>Jamaica</th>
<th>Kenya</th>
<th>Pakistan</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANOVA</td>
<td>0.42</td>
<td>0.13</td>
<td>0.41</td>
</tr>
<tr>
<td>$R^2$ for regression</td>
<td>0.41</td>
<td>0.08</td>
<td>0.38</td>
</tr>
<tr>
<td>Of the absolute values of the linear residuals on the official rate</td>
<td>0.42</td>
<td>0.10</td>
<td>0.41</td>
</tr>
<tr>
<td>Of the absolute values of the log-log residuals on the log of the official rate</td>
<td>0.24</td>
<td>0.04</td>
<td>0.21</td>
</tr>
<tr>
<td>Of the normalized squared residuals of the linear regression on the official rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size (N)</td>
<td>3,002</td>
<td>3,392</td>
<td>4,317</td>
</tr>
</tbody>
</table>

IV. HIGHER RATES, NOT HIGHER REVENUES

There are two well-established explanations of why tariff revenues will not increase one-for-one with increases in tariff rates. First, to the extent that import demand for a good has some elasticity with respect to the tariff rate, the value of the import in a category will decrease with an increase in the tariff rate (other things being equal, of course). Second, the value of imports reported for the collection of duties will decline with an increasing tariff rate, at any level of actual dutiable imports, because of underinvoicing, misdeclaration, and smuggling as the tariff rises.

This study documents a third reason why revenues will not rise (or fall) one-for-one with rates. Even for a given value of imports declared to customs, the collected rate itself will not rise one-for-one with rises in the official rates, because the ratio of imports coming in with exemption will increase as the tariff rate increases. This will happen for three reasons. First, even under a fixed set of exemptions (say, a scheme that provides exemptions to exporters), as the tariff is raised, the value of imports coming in under nonexemptions will decrease (with the magnitude depending on the price elasticity of the nonexempt goods), while the value coming in under exemption will remain constant, and this will increase the fraction under exemption. Second, the incentive to lobby for exemptions will increase with the level of tariffs. Exemptions either for specific types of goods or for specific importers, or just plain discretionary exemptions, are endemic in tariff systems. When the lobbying for exemptions and the degree of exemptions granted are endogenous, an increase in the rate will increase the fraction of imports coming in under exemptions. Third, the temptations for abuse of any system of exemptions will increase with the level of the tariff. For instance, exemptions are commonly granted to exporters, diplomatic missions, charitable activities, or returning residents. The higher the tariff, the larger the incentive for false diversion of imports into exempt channels.

6. This is not the same as an import-demand price elasticity, because in some cases (for example, under binding nontariff barriers) the tariff rate will not affect the price.
This third channel for a low revenue elasticity to tariff changes is potentially quite important, as seen in table 2. For Kenya the mean of the collected rate decreases from 43 percent at a 60 percent official rate, to 31 percent at an 80 percent rate, and to 36 percent at a 100 percent rate. For Pakistan the mean of the collected rate for items with a 60 percent tariff is 40 percent. For items with an 80 percent tariff, the mean of the collected rate increases to only 51 percent and then is roughly the same for items with official rates of 100 (52 percent) and 125 (54 percent).

If the official rate were collected on all imports, the collected rate for each tariff item would be equal to the official rate. In estimating equation 1 \( \text{Collected rate}_i = \alpha + \beta \times (\text{Official rate}_i) + \epsilon_i \), we should find \( \alpha = 0 \) and \( \beta = 1 \). We start with this simple linear model in the first row of table 5. If for each country, the slope (the response of the collected rate to a change in the official rate) is both substantively and statistically much less than one. An increase of 10 percentage points in the official rate produces an increase of only 4.7 percentage points in the collected rate for Jamaica, 4.9 for Kenya, and 3.3 for Pakistan. But many simulations of revenue loss from tariff reforms have relied essentially on the simple model above with \( \alpha = 0, \beta = 1 \).

The subsequent rows of table 5 verify that this basic result is robust to econometric variations. At the 5,000-item level, many import categories are quite small in terms of value; therefore we weight each observation by import value to be sure the coefficient estimates are not being driven by the data for the smaller import categories. The weighted ordinary least squares (OLS) results in row 2 show coefficients that are all lower, not higher, than the unweighted results. In row 3 we report another weighted regression, this time with the statutory rate as the weight. The coefficients are nearly the same as the OLS results (except for Pakistan, for which the figure is much lower).

The fourth row excludes those items for which the collection rate is zero even though recorded import values are positive. These may be tariff items that have a positive official rate reported but have been uniformly excluded from tariff collections for some reason. Some of these items are perhaps more accurately counted as items with a zero duty rate, and their presence might create a down-

---

7. The regressions in log-log form produce no better overall fit, and the conclusions are roughly the same.
8. Given the small standard errors of the coefficient estimates, the t-tests reject the null hypothesis that \( \beta = 1 \) at any reasonable significance level.
9. As noted above, a number of the import categories have zero value. The division of the tariff code leads to code items of intrinsically very different sizes. The ratio of the value of imports in the item of the 75th percentile to those in the 25th percentile is 27 for Jamaica, 75 for Pakistan, and more than 1,000 for Kenya.
10. Row 2 of table 4 is a Bruesch-Pagan test for heteroskedasticity that is linear in the statutory rate and that strongly rejects homoskedasticity. The problem of inconsistent standard error estimates is not a serious concern, because the White heteroskedasticity consistent standard error estimates produce essentially the same results. They do so because the standard errors are so small in relation to the coefficients. In all subsequent results, unsurveyed data are used, and in all tables uncorrected standard errors are reported.
Table 5. *Estimation Results of Regressing the Collected Rate on the Official Rate*

<table>
<thead>
<tr>
<th>Type of OLS regression</th>
<th>Jamaica</th>
<th></th>
<th>Kenya</th>
<th></th>
<th>Pakistan</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>$R^2$</td>
<td>Coefficient</td>
<td>$R^2$</td>
<td>Coefficient</td>
<td>$R^2$</td>
</tr>
<tr>
<td>Linear</td>
<td>0.47</td>
<td>0.30</td>
<td>0.49</td>
<td>0.21</td>
<td>0.33</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td></td>
<td>(0.01)</td>
<td></td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>Weighted by import</td>
<td>0.28</td>
<td>0.16</td>
<td>0.10</td>
<td>0.01</td>
<td>0.29</td>
<td>0.14</td>
</tr>
<tr>
<td>values</td>
<td>(0.01)</td>
<td></td>
<td>(0.02)</td>
<td></td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>Weighted by official</td>
<td>0.50</td>
<td>0.20</td>
<td>0.47</td>
<td>0.20</td>
<td>0.12</td>
<td>0.02</td>
</tr>
<tr>
<td>rate</td>
<td>(0.02)</td>
<td></td>
<td>(0.02)</td>
<td></td>
<td>(0.02)</td>
<td></td>
</tr>
<tr>
<td>Linear, excluding</td>
<td>0.50</td>
<td>0.31</td>
<td>0.31</td>
<td>0.12</td>
<td>0.38</td>
<td>0.20</td>
</tr>
<tr>
<td>observations where the</td>
<td>(0.01)</td>
<td></td>
<td>(0.01)</td>
<td></td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>collected rate is zero</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note:* The following equation was estimated: $\text{(collected rate')} = \alpha + \beta(\text{official rate'}) + \epsilon$. Standard errors are in parentheses. For the first three regressions, the number of observations for Jamaica is 3,002; for Kenya, 3,392; and for Pakistan, 4,317. When zero collected rates are excluded, the number of observations falls to 2,635, 2,116, and 3,790, respectively.

ward bias. This procedure of excluding all items with a zero rate will, however, also exclude items for which a tariff actually was in force but all imports received an individual exemption. Excluding these observations would produce an upward bias in the slope. The fourth row shows that the coefficients increased slightly, but not dramatically, for Jamaica and Pakistan, and decreased for Kenya.

The regression results express statistically the phenomenon evident in table 2 that an increase of, say, 20 percentage points in the tariff is likely to lead to a much less than 20-percentage-point increase in the ratio of revenue to import value. For instance, as the official ad valorem rate in Pakistan increased by increments of 20 percentage points—from 40 to 60 to 80—the average collected rates increased from 32 to 40 (8 points) to 51 (11 points).

Interestingly, at high levels of the official rate the increment seems to fall as the rates rise. Table 2 shows that, in Pakistan, increasing the official rate from 80 to 100 increases the collected rate by only one point and in Kenya an increase from 80 to 100 increases the collected rate by only five points. This suggests the relation might not be linear, a question we turn to in the next section.

V. MIGHT RATES BE OVER THE LAFFER CURVE?

Reducing tariff levels could actually increase revenue if increases in the official tariff rate above a certain level actually reduced the collection rate.\(^{11}\) This is one
way of producing a "Laffer effect." The first column for each country in Table 6 reports estimation results using a spline, which allows the slope of the relation between the collected and official rates to be different above and below a given level of the tariff.\(^\text{13}\) Algebraically, if \(t^*\) is the kink point,

\[
\text{Collected rate}_i = \alpha + \beta_0 (\text{Official rate}_i) + \beta_1 (\text{Official rate}_i - t^*) + e_i.
\]

The slope of the relation between collected rates and official rates below the rate \(t^*\) is \(\beta_0\), but above the rate \(t^*\) the slope is \(\beta_0 + \beta_1\). Table 6 reports the slope below and above the specified turning point (that is, \(\beta_0\) and \(\beta_0 + \beta_1\) and their standard errors, not the raw estimates \(\beta_0\) and \(\beta_1\) from equation 2).\(^\text{14}\) For all three countries we find strong evidence that the slope falls as the official rate rises. In Jamaica, above a tariff rate of 40 percent the slope falls from 0.43 to 0.11. For Kenya, below a tariff of 60 percent the slope is 0.58, but above that rate the slope is only 0.25. For Pakistan, below a tariff rate of 80 percent the estimated slope is 0.6, but above that point the slope is actually negative, \(-0.02\).\(^\text{15}\)

The second column for each country shows the result of the quadratic regression, which allows the slope to change continuously with the level of the tariff. Again there is some evidence of nonlinearity.\(^\text{16}\) The rate at which the collection rate rises as the tariff rate increases falls, and ultimately becomes negative for Kenya and Pakistan.\(^\text{17}\) The estimated turning point for Pakistan is 200. The data for Kenya are unusual. In Table 2 the collected rate falls from 43 percent for items with an official rate of 60 percent to 31 for 80 percent items and 36 for 100 percent items. This would suggest a sharp downward slope above 60. However, there are also 22 (of 3,400) items with a tariff of 135 percent for which the collection rate is 117 percent. These observations weaken the statistical findings of a negative slope for high tariff values.

The data suggest that the relation between official and collected rates is nonlinear, such that the increase in the collection rate for a 10-percentage-point

\(12\). The Laffer curve shows the relation of tax revenues to the tax rate. For example, for an income tax by assumption, zero revenue is collected at a 0 percent tax rate, and, plausibly, zero revenue is collected at a 100 percent tax rate, which extremes imply that tariff revenues are at a maximum for some rate between 0 and 100 percent taxation.

\(13\). A spline regression allows the regression to have a different slope above and below a certain point. The function itself is continuous, but without continuous first derivatives, because the slope jumps at the kink point.

\(14\). A different level of \(t^*\) was chosen for each country in an ad hoc way by picking a level of the official tariff substantially above the mean, yet with a substantial number of items above the rate. Some experimentation revealed the basic result (a kink in the relation) to be robust to the \(t^*\) specified.

\(15\). As shown by the standard errors, in each case the difference in the slopes is strongly statistically significant (that is, \(\beta + \beta_1\), but the smaller slope \((\beta + \beta_1)\) may or may not be statistically different from zero.

\(16\). Another indication of nonlinearity is that the Durbin-Watson statistic is quite low when the data are ordered before estimation by the official rate.

\(17\). If the model is \(\text{Collected rate} = \beta_0 (\text{Official rate}) + \beta_1 (\text{Official rate})^2\), then the slope is \(d\text{Collected rate} / d\text{Official rate} = \beta_0 + 2\beta_1 (\text{Official rate})\). The turning point of the regression, where the slope equals zero, is therefore \(-\beta_0/(2\beta_1)\).
Table 6. Nonlinear Terms in the Collected Rate–Official Rate Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Jamaica</th>
<th>Kenya</th>
<th>Pakistan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spline</td>
<td>Quadratic</td>
<td>Spline</td>
</tr>
<tr>
<td>Slope below turning point, $\beta_0$</td>
<td>0.43</td>
<td>0.39</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.06)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Slope above turning point, $\beta_0 + \beta_1$</td>
<td>0.11</td>
<td>0.25</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.04)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Quadratic term (official rate $^2$)</td>
<td>0.000</td>
<td>-0.00028</td>
<td>-0.0015</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.00043)</td>
<td>(0.0001)</td>
</tr>
<tr>
<td>$t^*$ (for spline) or turning point (for quadratic)</td>
<td>40</td>
<td>n.a.</td>
<td>60</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.29</td>
<td>0.29</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses. Number of observations are 3,000 (two outliers were deleted), 3,392, and 4,317.

increase in official rates is much smaller for higher rates than for lower rates. We do not, however, find strong evidence of Laffer effects in collected rates alone (a very weakly sufficient condition for falling revenues). But the nonlinear relation between official and collected rates does add an additional channel to the usual mechanism (of falling tax base) for Laffer effects to appear. The nonlinear relation between collected rates and official rates has important implications for the revenue consequences of "concertina" type tariff reforms that push rates down from the top and up from the bottom.

VI. ARE THESE COUNTRIES SPECIAL?

The three countries analyzed here are simply those for which we were able to acquire data on tariffs, import values, and revenue at the detailed level necessary. We suspect that these countries are typical and that the wide divergence between the official rates of the individual items and the collection of revenue is a common feature of prereform tariffs. We present two pieces of evidence for this view: comparisons of aggregate revenues and hypothetical revenues across countries, and studies of exemptions in several countries.

The import-weighted average tariff rate gives the ratio of hypothetical revenue to imports, that is, the ratio of total tariff revenue to import values that would result if import duties were fully collected at the single official rate on all imports. It has been noted that the import-weighted average diverges widely from the aggregate ratio of revenue to collections. In earlier work (Pritchett and Sethi 1993), we find that for the eight countries for which we can calculate both the trade-weighted average and the ratio of import duty to imports, the excess of hypothetical over actual revenue varies from quite small (55 percent compared with 51 percent for India) to immense (32 percent compared with 7 percent for Brazil). In Nogues and Gulati (1992, tables 1.1, 1.3, 1.5, and 3.10) the ratios

18. For these countries the information on import duties is from International Monetary Fund (various issues—a), because we do not have data on actual collections.
of the weighted average tariff rate and the aggregate collection rate (in a pre-
reform year) are 39 percent compared with 17 percent in Argentina (1988), 16
percent compared with 7 percent in Costa Rica (1988), and 45 percent com-
pared with 16 percent in Peru (1989).

Kostecki and Tymowski (1985) review the import-weighted average tariff and
the collected rate (which they call the “ad valorem incidence”) and find substan-
tial divergence between the two, with collected rates generally half or less than
half of the trade-weighted average. The magnitude was quite different across
countries: in 1977 the trade-weighted average in Venezuela was around 27
percent while collections were 4.7 percent; the trade-weighted average in Col-
ombia was around 22 percent, but collections were 12.3 percent. Erzan and
others (1989) review the structure of protection for a large number of develop-
ing countries as of 1985 and give the average import-weighted level of tariffs
(including what they refer to as “para-tariffs,” which are [non-import-duty]
charges levied on imports, such as customs charges, stamp taxes, and taxes on
foreign exchange transactions, but not sales or excise taxes). They report an
average of 30 percent, ranging from 66 percent in Central America to 5 percent
in western Asia. A comparison with figures from the International Monetary
Fund (various issues—a, —b) for similar years finds average collection rates
generally between 10 and 20 percent (except for a few high-collection countries,
such as India).\textsuperscript{19}

So far we have presented indirect evidence of the importance of exemptions,
provisionally defined as deviations of revenue actually due from revenue at
standard duty rates. Exemptions, including preferential lower tariff rates, which
are partial exemptions, are granted for a wide variety of reasons: country of
origin (for example, members of customs unions or regional arrangements), end
use (for example, imports for exports), type of importer (for example, charities
or parastatals), type of financing (for example, donor-financed imports or for-
eign investment), or simply discretionary exemptions granted for worthy causes.

In Pakistan, exemptions are granted for a wide variety of general and specific
purposes. Concessionary duties for imports of plant and machinery are granted
to “key” industries. Industrial units located in rural areas are allowed to import
machinery free of customs duties (or sales tax). Industrial undertakings in design-
nated industrial estates are given duty free access to raw materials. Parts or raw
materials for specific industries being encouraged are given trade tax conces-
sions, for example, parts for tractors or nylon chips. Kenya’s tariff regime also
provides numerous ad hoc exemptions for imports of capital and intermediate
goods. The tariff regime in Jamaica has more than 90 different categories of
exemptions and incentive regimes, and these affect the duties due on 41 percent
of all non-zero-rated dutiable imports.

\textsuperscript{19} The ratio of revenue from import duties are from International Monetary Fund (various issues—a,
line 6.1); imports, including cost, insurance, and freight, in local currency are from International Mone-
tary Fund (various issues—b, line 71).
Unfortunately, we do not have information for these countries on the magnitude of the exemptions by type. What fraction of the foregone revenue is from duty free imports for exporters? With traditional duty drawbacks the revenue is recorded as collected and then recorded again when rebated. But we do not know what fraction is from concessions to promote particular industries or regions, or what fraction is from discretionary or ad hoc exemptions given to particular firms or institutions. This is obviously an important distinction, not only for revenue calculations but also for analysis of the fiscal costs of these “tax expenditures” as well as for the implications for trade protection. Direct evidence on the amount of tariff revenue lost to exemptions is difficult to obtain.

There is some direct evidence from other countries that our findings are not peculiar to just Jamaica, Kenya, and Pakistan. In 1988 Brazilian parastatals paid almost no tariffs (0.5 percent of import value), while private firms paid a substantial tariff (13.4 percent, although this is still a small fraction of the import-weighted tariff, which is 39.8 percent) (World Bank data). Foroutan (1990) finds a large amount of revenue lost in Argentina to import exemptions of various types, particularly regional promotion. A study in 1988 in Tanzania found that one-third of all exemptions were made under the discretionary authority granted to the Minister of Finance (World Bank data).

We have data from Côte d’Ivoire on the tariff rate, import values, and the value of imports that are fully exempt from tariffs, but we have no information on revenues. The proportion of import values that are exempt increases significantly with the level of the official tariff (table 7). For India we have data on import tariff levels and collected rates, but only aggregated to the two-digit tariff code level.20 Here again, we find that the collected rate increases much more slowly than the official tariff. The available evidence suggests that exemptions are a prominent feature of prereform tariff systems in many, if not most, countries.

VII. IMPLICATIONS AND CONCLUSIONS

As usual, correctly interpreting the implications of the facts we document is much more difficult than documenting the facts. The distinction between changes in tariff rates that occur when all other aspects of the tariff regime remain constant and changes in tariff rates that occur simultaneously with other changes (for example, changes in procedures for receiving exemptions) is important. A calculation of the revenue implications of a change in tariff rates that estimates hypothetical revenue under the existing rates and revenue under the new rates is probably worse than useless. If the change in rates includes the system of granting exemptions, then this calculation will vastly overstate the revenue lost.

20. There must be some bias as a result of aggregation (although we have not figured out which way it goes), but the slope is surprisingly similar to other results.
Table 7. Regressions for Countries without Detailed Revenue Data on the Official Rate

<table>
<thead>
<tr>
<th>Variable or statistic</th>
<th>Côte d'Ivoire (1988)</th>
<th>India (1986)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
<td>Percentage of fully exempt imports in total import value</td>
<td>Average ratio of collections to imports at two-digit chapter</td>
</tr>
<tr>
<td>Official rate</td>
<td>0.26 (0.042)</td>
<td>0.24 (0.08)</td>
</tr>
<tr>
<td>R²</td>
<td>0.016</td>
<td>0.09</td>
</tr>
<tr>
<td>Number of observations</td>
<td>2,507</td>
<td>92</td>
</tr>
</tbody>
</table>

Note: Standard errors are in parentheses.
Source: World Bank data.

In Pakistan, for example, the revenue foregone from a concertina reform that lowered all rates to 80 percent would in fact be minimal because the collection rates essentially level off at 50 percent (table 2). The “hypothetical revenue lost” under the standard assumption would be the total import value of those items above 80 percent times the difference between the previous tariff and 80 percent, which is a substantial number. In Kenya, collected rates are lower for items with high tariffs than for those with moderate tariffs. Moving high-tariff items to lower rates would actually increase revenue, rather than cause the loss that calculating “hypothetical revenue” would suggest. (This would be true if the high-tariff items then had the same collection performance as other items at the lower rate but possibly not true if the high rate and exemptions were acting as a discretionary quota.) The revenue impact of raising rates from low levels in a concertina reform would have a very different (positive) impact on collections than an equivalent percentage-point reduction at the top end.

Of course, tariff reform generally includes broader treatment of the tariff regime than just a change in tariff rates. The relation between collection rates and official rates might change if, for example, exemptions were curtailed. The revenue implications of large changes in rates can be offset by modest changes elsewhere in the system of exemptions (and in areas such as smuggling, under invoicing, and false customs declarations). In addition, the endogenous pressures that cause collected rates to increase less than one for one with tariff rates will continue to be present in any tariff regime with dispersion in tariff rates, although these incentives are diminished as dispersion is reduced.

Many exemptions are actually “tax expenditures,” and a collection of the tax and allocated expenditures elsewhere would be a wash in the budget. For instance, an exemption from import duties for exporters would be roughly equivalent to a duty drawback that collects the revenue and then pays it out again to exporters. A tariff exemption to government agencies is potentially irrelevant to the budget, because a collection of the duty with offsetting increases in their budget would produce the same effect if import decisions were unaffected. (Of course a tariff exemption is not a wash in a welfare sense if the government agency or public sector choices about imports are influenced by the exemption.)
In these cases, the benefit of eliminating exemptions is primarily transparency, because the costs of programs that provide import exemptions for, say, regional promotion, are often hidden in the customs statistics.

The implications of the wide divergence between collected rates and official rates are most problematic in the analysis of the protection provided by tariffs. An initial inclination is to use the average ratio of collections to import value as the "effective" tariff for an item. However, whether or not this approach is correct depends on why revenues are less than the official tariff, because the relevant rate is, of course, the marginal tariff rate. The following three examples will, we hope, clarify the point.

- Say the tariff is 50 percent, but parastatals are exempt. If parastatals are responsible for 80 percent of the imports, the ratio of import duty to import value will be only 10 percent. Nevertheless, if the parastatals are effectively forbidden to resell, the marginal price an importer would have to pay would be the full tariff of 50 percent. If any imports come in at the full 50 percent, then it is this marginal tariff rate that will influence domestic prices.
- Say the tariff rate is 50 percent, but a regional preferential arrangement stipulates that imports from country X receive a rate of just 25 percent. If country X can fully satisfy the demand for the item, then the marginal and average tariff will be the 25 percent preferential rate, and it would be correct to use the ratio of import duty to value (25 percent) instead of the "official" rate (50 percent).
- Say the tariff is 50 percent, but a complete exemption is granted to some group (say, charitable organizations), and resale is not effectively prohibited. Then the marginal and average tariff rates for calculations of protection would be zero. However, if some group (say, foreign firms) is unable to take advantage of the secondary market for exempt imports and is thereby forced to pay the full rate and if this group accounts for 20 percent of the total import value, then the official rate would be 50 percent, the average collected rate would be 10 percent, and the correct marginal rate for incentive analysis would be zero.

The large divergence between official and collected tariffs does not have any simple implication for analyzing how tariffs affect incentives. In some cases an exemption will not reduce the protection provided; it will just create an (implicit) subsidy to the exempted activity. In other cases an exemption will effectively lower the protection provided by the tariff. Thus, there is a long list of reasons why analyzing the protection from nominal tariff rates is problematic.

References

The word "processed" describes informally reproduced works that may not be commonly available through library systems.


The Effect of Financial Liberalization on the Capital Structure and Investment Decisions of Indonesian Manufacturing Establishments

John R. Harris, Fabio Schiantarelli, and Miranda G. Siregar

This article analyzes the consequences of financial liberalization, using a large panel of Indonesian manufacturing establishments. It discusses whether financial reforms have had an impact on investment and on the allocation of credit and whether the effects differ depending on the type of firms. The overall conclusion is that shifting from administrative toward market-based allocation of credit has increased borrowing costs, particularly for smaller firms, but, at the same time, has benefited firms by giving them widened access to finance.

Since 1968 Indonesia has had a high rate of growth, facilitated considerably by the high oil prices in the 1970s and early 1980s. As an oil exporter, Indonesia experienced two major booms: 1974–77 and 1979–82. Under the clear recognition that oil revenues were a temporary blessing, Indonesia's overall policy was directed toward using the revenues to stimulate investment so as to assure sustained growth after the oil became depleted. A central goal of government policy was to foster growth in the manufacturing sector by channeling money to the private industrial sector through the banking system. During the boom periods the banks were instructed to finance at low interest rates certain types of investment, particularly in import substitution and backward integration of heavy industries.

Following sharp declines in oil revenues in late 1982 and again in 1986, policymakers recognized the need for major reforms. First, non-oil exports had to be increased to maintain the flow of imports essential for continued development. Second, with the decline in oil revenues, fewer resources were available to the public sector, and therefore it became necessary to stimulate private savings...
mobilization. An integral part of the policy reform was deregulating the banking system in June 1983. The deregulation allowed banks to set interest rates, substantially reduced central bank liquidity credits, and abolished administratively determined credit ceilings. The general objective was to move away from administrative control to market allocation of credit flows.

In 1986, when oil prices fell further, the government was again forced to devalue the currency, and further deregulation measures were taken. The continuing evolution of policy toward increased market orientation reached its peak in 1988 in a series of major policy reforms affecting primarily the banking, capital markets, trade, and tax systems. The reforms have had a significant impact on the real sector.

This article assesses the effects of the reforms, in particular the financial reforms, on the structure and behavior of manufacturing industries in Indonesia. How did credit allocation change with financial deregulation? What was the impact on firms' investment choices? Did the effects of reform differ across firms? To answer these questions, we use data from a panel of manufacturing establishments in Indonesia during 1981–88.

Section I contains a macroeconomic overview. Section II discusses the structure of manufacturing industries and the determinants of access to credit markets. Section III describes the economic and financial evolution of establishments during the 1980s. Section IV presents econometric evidence on the effects of financial liberalization on investment behavior. The conclusion summarizes the main findings.

I. MACROECONOMIC AND POLICY DEVELOPMENTS IN INDONESIA

This section provides a review of the macroeconomy during 1973–88 and of the effects of the 1983 deregulation of the banking sector.

The Macroeconomic Background

From 1973 through 1982, Indonesia enjoyed prosperity fueled by high oil prices. Macroeconomic policy was fairly sound, and was concerned with keeping inflation under control and maintaining a prudent fiscal policy. A cautious policy toward foreign borrowing kept the country's debt service ratio fairly low throughout the boom period. But the government was less successful in controlling inflation, because of its inability to sterilize oil revenues. By the end of 1982 the economy was overheated, with high levels of oil-related public investments and an upsurge in private investments accompanied by protectionist and interventionist policies.

Falling oil prices in 1983, together with the worldwide recession and an increase in the U.S. real interest rate, worsened Indonesia's balance of payments, thereby impairing its ability to service debt. The government responded by devaluing the rupiah by 50 percent at the end of March 1983, primarily to boost non-oil exports. Following this large discrete devaluation, the foreign exchange regime was changed to a crawling peg system. To reduce both external and internal imbalances, a series
of austerity measures was introduced, and the government moved quickly to mobilize domestic resources through reforms in the financial sector and improved collection of non-oil tax revenues (see Chant and Pangestu 1992).

Before June 1, 1983, Indonesia had most of the characteristics of a financially repressed system. The banking sector was heavily regulated, and entry was very restricted. The market was dominated by state banks, with Bank Indonesia alone accounting for 35 percent of the total assets of the financial system and the five large state banks holding another 40 percent. Bank Indonesia set ceilings on bank credits for individual banks, and this was the principal way to control monetary expansion. It was believed that reserve management alone was insufficient, given the volatility of international financial flows, including oil revenues, and given the absence of restrictions on private capital movements. Over time an extensive selective credit system with subsidized interest rates was introduced. Moreover, Bank Indonesia provided direct lending to some economic units and channeled substantial amounts of low-interest liquidity credits to high-priority or strategic sectors. These were the tools for channeling oil earnings to the private and para-statal sectors to increase investment. When the volume of oil revenues fell precipitously, the principal task facing the financial sector changed quickly to the mobilization of domestic resources.

Indonesia's trade and industrial policies were basically protectionist and were primarily implemented through a detailed licensing system. Together with the trade and industrial policies, the cheap-credit policy helped to create a few dominant economic groups or conglomerates, which prospered because of their ability to make use of the administrative allocation systems (Robison 1986). Efforts to increase the mobilization of domestic funds through the financial sector and to improve the collection of non-oil tax revenues were reflected in significant reforms in the 1983 banking deregulation and in the tax reforms of 1984. The principal objectives of the banking deregulation were to provide higher returns to depositors and lower costs to borrowers by raising the degree of competition in the financial markets, to increase savings mobilization through the banking system, to allocate financial resources more efficiently through increased reliance on the market mechanism, and to increase the use of capital market instruments to raise equity capital and enhance the liquidity of shares.

The measures taken included abolishing credit ceilings, reducing liquidity credits, and granting permission for state banks to set their own interest rates on deposits and loans. Each of these measures required drastic changes in the behavior of banks and in the techniques of liquidity management. All banks were subjected to much greater competition and became responsible for acting on their independent assessments of profitable opportunities. The immediate effects of the 1983 banking reforms were to substantially increase interest rates paid on deposits and charged for loans and to increase the share of gross domestic product (GDP) being channeled through the formal financial system. The anticipated changes in competitive behavior emerged only slowly and were really given impetus with the reforms in 1988 and 1989.
Table 1. Volume of Credit through the Banking System in Indonesia, 1980–89

<table>
<thead>
<tr>
<th>Year</th>
<th>Total credit</th>
<th>Credit to manufacturing</th>
<th>Percentage of total credit, by source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Billions of rupiah</td>
<td>Billions of rupiah</td>
<td>State banks</td>
</tr>
<tr>
<td>1980</td>
<td>7,874</td>
<td>2,213</td>
<td>55</td>
</tr>
<tr>
<td>1981</td>
<td>10,159</td>
<td>2,762</td>
<td>58</td>
</tr>
<tr>
<td>1982</td>
<td>13,022</td>
<td>3,923</td>
<td>62</td>
</tr>
<tr>
<td>1983</td>
<td>15,299</td>
<td>5,207</td>
<td>64</td>
</tr>
<tr>
<td>1984</td>
<td>18,813</td>
<td>6,667</td>
<td>71</td>
</tr>
<tr>
<td>1985</td>
<td>22,157</td>
<td>7,592</td>
<td>69</td>
</tr>
<tr>
<td>1986</td>
<td>26,402</td>
<td>9,005</td>
<td>67</td>
</tr>
<tr>
<td>1987</td>
<td>32,852</td>
<td>10,917</td>
<td>66</td>
</tr>
<tr>
<td>1988</td>
<td>44,001</td>
<td>14,956</td>
<td>65</td>
</tr>
<tr>
<td>1989</td>
<td>63,606</td>
<td>20,333</td>
<td>62</td>
</tr>
</tbody>
</table>

Note: A billion is 1,000 million.
Source: Bank Indonesia (various issues—a, various issues—b).
The fall in oil prices from $28 a barrel to $9 a barrel by August 1986 forced the government to carry out a maxi devaluation of the currency—by 45 percent, in September 1986—to improve the country's balance of payments. The plummeting oil and primary commodity prices shocked the government and induced it to accelerate the introduction of reforms designed to stimulate non-oil exports. This article concentrates on the changes that occurred in the mid-1980s. We refer to 1981–84 as a “preliberalization” or “prereform” period, under the assumption that changes instituted late in 1983 did not affect financial and investment decisions until well into 1984. We refer to 1985–88 as a “postliberalization” or “postreform” period. This pre-post dichotomization suggests a once-and-for-all shift in regime that considerably exaggerates the reality. Rather, there was a fairly continuous process of liberalization of various aspects of the economy after mid-1983. Furthermore, the response of economic agents to these reforms occurred fairly gradually. Nevertheless, for our purposes, the 1983 reforms were extremely significant for increasing the levels of real interest rates and reducing the credit controls placed on individual banks. The dominant state banks were forced to act more autonomously and to base their lending decisions more on commercial criteria than had been the case before the reforms.

Effects of the 1983 Banking Deregulation

Following the 1983 banking deregulation, interest rates on deposits at the state banks almost doubled. For example, the average interest rate on six-month time deposits at state banks rose from 6 percent a year in March 1983 to 11.5 percent a year one month later. At the same time, private banks increased their deposit rate from 18.3 percent to 20.0 percent. Consequently, the banking industry had to adjust its lending rates to remain profitable in a competitive market. As a result of the increasing share of short-term fixed-rate liabilities, the banks became more cautious in their credit policies. It was widely believed that the high cost of intermediation and the high credit risk of the financial system caused an unusually large spread between lending and deposit rates.

In assessing the effects of the reforms in the 1983 banking deregulation, it is critical to remember that, in response to higher interest rates, there was a shift toward financial intermediation in the Indonesian economy. Table 1 shows the expansion of bank-intermediated credit rising from 17 percent of GDP in 1980 to 38 percent in 1989, mirroring the mobilization of resources through interest-bearing deposits. Table 1 also shows that the share of credit extended to manufacturing increased during this period, further reinforcing the quantity effects of the reforms. Thus the basic pattern in Indonesia following the reforms was a vast increase in the supply of bank credit at substantially higher real interest rates.

The other aspect of the reforms shown in table 1 is the changing structure of the banking industry and the channels through which credit was extended. Bank Indonesia sharply reduced its direct role in lending, part of which was replaced by lending through state commercial banks. Over time the role of private banks became important, their share of lending rising from 9 percent in 1980 to 29 percent in 1989.
Table 2. Lending Rates in Indonesia, 1981–88
(percent per year)

<table>
<thead>
<tr>
<th>Year</th>
<th>Nominal lending rate (i)</th>
<th>Inflation rate (r)</th>
<th>Real lending rate (i_r)</th>
<th>Six-month LIBOR (i_w)</th>
<th>Percent-change in exchange rate (δ)</th>
<th>Effective cost of foreign loans (i = i_w + δ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>9.00</td>
<td>9.50</td>
<td>-0.46</td>
<td>16.72</td>
<td>0.28</td>
<td>17.00</td>
</tr>
<tr>
<td>1982</td>
<td>9.00</td>
<td>10.80</td>
<td>-1.62</td>
<td>13.60</td>
<td>4.68</td>
<td>18.28</td>
</tr>
<tr>
<td>1983</td>
<td>11.00</td>
<td>12.40</td>
<td>-0.36</td>
<td>9.93</td>
<td>41.48</td>
<td>51.41</td>
</tr>
<tr>
<td>1984</td>
<td>15.00</td>
<td>8.80</td>
<td>5.70</td>
<td>11.29</td>
<td>7.74</td>
<td>19.03</td>
</tr>
<tr>
<td>1985</td>
<td>19.00</td>
<td>6.60</td>
<td>11.69</td>
<td>8.64</td>
<td>5.42</td>
<td>14.06</td>
</tr>
<tr>
<td>1986</td>
<td>21.00</td>
<td>7.80</td>
<td>12.83</td>
<td>6.25</td>
<td>46.40</td>
<td>52.65</td>
</tr>
<tr>
<td>1987</td>
<td>21.70</td>
<td>9.20</td>
<td>12.08</td>
<td>7.93</td>
<td>0.03</td>
<td>7.96</td>
</tr>
<tr>
<td>1988</td>
<td>22.40</td>
<td>10.30</td>
<td>10.97</td>
<td>9.43</td>
<td>4.00</td>
<td>13.41</td>
</tr>
</tbody>
</table>

a. LIBOR (London interbank offered rate) was chosen because it was extensively used as a benchmark in most foreign loan agreements.

b. δ is the ex post exchange rate depreciation at the end of the calendar year and was chosen because the forward exchange rate market did not exist in Indonesia.

Source: Bank Indonesia (various issues—a, various issues—b); International Monetary Fund (various issues).

Table 2 displays the increase in nominal and real interest rates following deregulation. The average nominal lending rate increased from about 9 percent in 1981 to about 22.5 percent in 1988. The associated real lending rate increased from -0.46 in 1981 to 10.97 by the end of 1988. The abrupt increases in the real rate in 1984 and 1985 were caused by the deregulation-induced jump in nominal interest rates, whereas inflation had been stabilized at rates well below 10 percent. Deposit rates showed exactly the same movement, whereas nominal spreads between 90-day deposit rates and prime commercial lending rates remained close to 5 percent.

Table 2 also presents data on the effective cost of foreign loans to Indonesian borrowers. Comparing these figures with the nominal lending rate on rupiah-denominated credit, it is clear that before 1984 Indonesian interest rates remained far below lending rates in Singapore and Hong Kong. This made Indonesian credit a bargain for those borrowers granted access to loans. Of course, Bank Indonesia had to control the levels of lending, because there must have been substantial excess demand. Without controls, one would expect interest rate parity to apply between Indonesian and offshore borrowing costs, because competition for credit would have driven rates up until they were appropriately in line with foreign rates. At the same time, competition among banks for deposits in response to higher lending rates should also have driven deposit rates up to parity with foreign rates.¹

¹. The interest rate parity condition that should apply between any two countries between which capital is perfectly mobile can be written, assuming perfect foresight, as \( i = i_w + \delta \), where \( i \) is the effective cost in rupiah of borrowing in dollars, \( i_w \) is the nominal foreign interest rate, and \( \delta \) is the rate of depreciation of the rupiah-dollar exchange rate. This equation merely states that the effective lending rate will be the same regardless of the currency in which the loan is contracted.
It remains a puzzle how Indonesian banks were able to maintain deposit rates that were so much lower than foreign rates before 1984. There were no controls on capital flows, and Indonesians could hold deposits in either dollar- or rupiah-denominated accounts in local banks. Although domestic deposits held in foreign banks must have been substantial, we have no systematic record of the levels. The enormous deposit holding in response to higher interest rates suggests that considerable substitution between dollar- and rupiah-denominated accounts occurred. However, it remains clear that rupiah- and dollar-denominated deposits are imperfect substitutes. The point is reinforced by the positive differential in interest rates adjusted for devaluation after the deregulation.

In response to the 1983 reforms, Indonesian nominal interest rates rose while international nominal rates declined. In fact, the adjustment "overshot," in that Indonesian deposit and lending rates were higher than the levels that would have been dictated by interest rate parity. By 1988, adjusted foreign-borrowing rates were considerably lower than in Indonesia, and this trend accelerated after 1989.

With the average interest on rupiah loans nearly 22 percent a year after 1984, established Indonesian firms could borrow at the Singapore or London interbank offered rate (SIBOR or LIBOR, respectively) plus a 0.5 to 2.0 percent risk premium, which resulted in nominal loan rates ranging between 7.5 and 10 percent. With a foreign exchange swap facility available at premiums of between 4.5 and 6 percent, the implied rupiah interest rate on foreign loans was between 12 and 16 percent. As far as exporters were concerned, borrowing offshore was a source of cheaper funds, even without the swap facility, because their dollar-denominated export revenue could protect them from exchange rate risk.

Thus deregulation substantially increased the returns to holding rupiah-denominated deposits and, at the same time, increased the advantages obtainable by firms with access to offshore borrowing. These results have raised a hotly debated issue in Indonesia: whether the reforms that have increased interest rates have served to help or to hinder smaller and nonconglomerate firms, which have less access to "cheap" offshore borrowing.

II. Indonesia's Manufacturing Firms and Their Access to Credit Markets

Indonesian manufacturing has grown remarkably since the early 1970s, maintaining real growth rates of value added in excess of 12 percent a year. The best description of the changing structure of firms by sector, size, and ownership is provided by Hill (1990a, 1990b). At the same time, Indonesian credit markets have been highly segmented, and different kinds of Indonesian firms enjoy very different access to capital. The ability to obtain external funds in domestic credit markets differs between small and large firms, between Chinese and non-Chinese firms, between private and public enterprises, between firms affiliated with, and owned by, a group and independent firms, and between export- and domestic-oriented firms. Moreover, the lack of exchange rate controls makes it possible for
firms that have established good reputations and close connections in other coun-
tries to borrow money from offshore.

There are significant differences among Indonesian firms, which affect their ac-
tess to foreign loans. Basically, the foreign option was open to conglomerates, to
large Chinese firms with connections to the financial markets in Singapore and
Hong Kong, to foreign firms, and to exporters with established overseas customer
relationships.

Access to domestic credit also differs across firms. Although there were special
credit schemes for small-scale industries, such as KIK and KMKP, they represented
only a very small part of the total implicitly subsidized credit from state banks. The
quantities of credit provided at explicitly subsidized rates amounted to only 0.14
percent of the total credit provided by state banks in 1981 and declined to 0.06 per-
cent by 1988. Thus, although these special credit schemes were showcase programs
during the period of financial-market controls, they provided an insignificant level
of resources to the targeted sector. Indeed, the bulk of state bank credit extended be-
fore the 1983 reforms went to the larger firms, which had political connections, in-
fluence, and special channels to the banks because of their longtime relationships,
coupled with their ability to provide assets as collateral. Relatively new (young), in-
dependent firms, which had not built up their reputation and political connections,
faced highly constrained access to the pool of low-cost credit.

In summary, there are profound differences among Indonesian firms in their ac-
tess to credit markets. The differences are not only in the duration and interest rates
of loans, but also in their currency denomination. Some firms (in particular, small,
non-Chinese, independent, and young firms) are likely also to face severe informa-
tion problems and lack of political connections. This limits their ability to obtain
funds from the formal credit markets (domestic or foreign) and forces them either to
rely on internal finance or to raise funds from the informal markets. Other firms, in
particular those belonging to conglomerates, as well as large Chinese firms, joint
ventures with foreigners, and public enterprises, are likely to have privileged access
to the domestic credit market combined with the ability to borrow offshore. The
differential access to, and cost of, external finance for different categories of firms is
likely to have a profound effect on their investment choices.

III. Economic and Financial Developments: Evidence from a Panel
of Indonesian Manufacturing Establishments, 1981–88

In this section we focus on the evolution of the real and financial characteris-
tics of a panel of Indonesian manufacturing establishments during 1981–88. We
then look at how banking reforms affected the distribution of debt across differ-
ent types of firms in the sample.

The Data and Summary Statistics

The panel of manufacturing establishments has been constructed by taking ad-
vantage of information from two main sources. The first source is the annual sur-
vey of manufacturing establishments, conducted by the Central Bureau of Statistics since 1975. The survey includes financial data available only after 1981. The second source is the Census of Manufacturing Industry conducted in 1986, which contains a measure of the replacement value of the capital stock and a breakdown of sales between the export and domestic markets, data that are not available from the annual surveys.

After checking for the consistency of the data throughout the whole sample period, deleting establishments that have nonpositive capital stock or value added, and omitting outliers, we ended up with a sample of 2,970 establishments that have at least three sequential years with positive output and at least one year with positive investment. We base the analysis in this section on this sample. The appendix describes the selection of establishments and the methods used to construct the variables.

That the data are based on establishments poses a problem we have been unable to fully overcome. Most of the analysis of credit market segmentation applies to firms. When firms own or control multiple establishments, the unit for which debt and interest payments is reported is somewhat arbitrary. This certainly applies to the establishments that belong to conglomerate groups. We believe that most of the establishments that we identify as nonconglomerate are single-establishment firms and, if so, there should be no confusion on this account. It is safe to assume that virtually all of the establishments we classify as "small" are in fact single-establishment firms—only 11 of the 777 in this class are members of conglomerate groups. However, it is possible that some are units of family enterprises that may also be engaged in nonmanufacturing activities. We have no way of controlling for this possibility.

Another feature to remember is that the sample is restricted to establishments that existed for at least four years and employed at least 20 persons. These selection criteria require that establishments that began production later than 1986 are omitted along with those that carried out no new investment, either for replacement or expansion. Therefore, these data are limited to relatively well-established firms that were able and willing to expand their plant and equipment during the period. The interesting question that cannot be addressed by these data, therefore, concerns the access to capital for new entities.

The key summary statistics for the sample of 2,970 establishments are given in tables 3, 4, and 5. These tables present the data for the entire sample as well as for subsamples chosen according to the firm's size, organizational form (conglomerate or nonconglomerate), and market orientation (exporting or nonexporting).² The subsamples related to size were obtained by classifying firms into three categories according to the number of workers. We classify an establishment as small if the number of workers during the first year of observation was 20 to 99, medium-size if

². The Central Bureau of Statistics does not collect data on the ethnicity of owners of establishments. Thus it is impossible to identify Chinese-owned firms. However, most of the conglomerates are controlled by Chinese shareholders.

<table>
<thead>
<tr>
<th>Size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Gross physical investment/capital stock a (I/K)</th>
<th>Operating surplus gross of interest payments/capital stock b (P/K)</th>
<th>Operating surplus net of interest payments/capital stock minus debt (S/ Eq)</th>
<th>Stock of debt/capital stock a (D/K)</th>
<th>Interest payments/stock of debt (i/D)</th>
<th>Value added/capital stock a (VA/K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>777</td>
<td>1981–84</td>
<td>0.040</td>
<td>0.203</td>
<td>0.193</td>
<td>0.225</td>
<td>0.235</td>
<td>0.280</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.075</td>
<td>0.390</td>
<td>0.467</td>
<td>0.453</td>
<td>0.297</td>
<td>0.524</td>
</tr>
<tr>
<td>Medium</td>
<td>1,336</td>
<td>1981–84</td>
<td>0.075</td>
<td>0.330</td>
<td>0.578</td>
<td>0.597</td>
<td>0.162</td>
<td>0.389</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.085</td>
<td>0.403</td>
<td>0.711</td>
<td>0.78</td>
<td>0.178</td>
<td>0.500</td>
</tr>
<tr>
<td>Large</td>
<td>857</td>
<td>1981–84</td>
<td>0.052</td>
<td>0.300</td>
<td>0.489</td>
<td>0.512</td>
<td>0.120</td>
<td>0.322</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.065</td>
<td>0.500</td>
<td>0.934</td>
<td>0.566</td>
<td>0.167</td>
<td>0.505</td>
</tr>
<tr>
<td>All firms</td>
<td>2,970</td>
<td>1981–84</td>
<td>0.059</td>
<td>0.288</td>
<td>0.419</td>
<td>0.525</td>
<td>0.169</td>
<td>0.341</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.076</td>
<td>0.428</td>
<td>0.759</td>
<td>0.599</td>
<td>0.206</td>
<td>0.508</td>
</tr>
</tbody>
</table>

Note: We classify an establishment as small if the number of workers during the first year of observation was 20 to 99, medium-size if the number of workers was 100 to 500, and large if the number of workers was greater than 500.

a. Capital stock includes land, buildings, machinery, equipment, and other items, at replacement value.
b. Gross of tax and depreciation.
c. Not including trade credit.

Source: Authors' calculations based on survey data. See appendix for details.
<table>
<thead>
<tr>
<th>Organizational form and size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Gross physical investment/capital stock (I/K)</th>
<th>Operating surplus of interest payments/capital stock (P/K)</th>
<th>Operating surplus net of interest payments/capital stock minus debt (S/Equ)</th>
<th>Stock of debt/capital stock (D/K)</th>
<th>Interest payments/stock of debt (I/D)</th>
<th>Value added/capital stock (VA/K)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nonconglomerate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>766</td>
<td>1981–84</td>
<td>0.038</td>
<td>0.230</td>
<td>0.220</td>
<td>0.210</td>
<td>0.268</td>
<td>0.272</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.070</td>
<td>0.370</td>
<td>0.417</td>
<td>0.405</td>
<td>0.300</td>
<td>0.526</td>
</tr>
<tr>
<td>Medium</td>
<td>1,203</td>
<td>1981–84</td>
<td>0.065</td>
<td>0.405</td>
<td>1.003</td>
<td>0.742</td>
<td>0.197</td>
<td>0.368</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.085</td>
<td>0.458</td>
<td>1.006</td>
<td>0.680</td>
<td>0.200</td>
<td>0.481</td>
</tr>
<tr>
<td>Large</td>
<td>727</td>
<td>1981–84</td>
<td>0.050</td>
<td>0.292</td>
<td>0.351</td>
<td>0.270</td>
<td>0.130</td>
<td>0.311</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.062</td>
<td>0.370</td>
<td>0.467</td>
<td>0.358</td>
<td>0.196</td>
<td>0.495</td>
</tr>
<tr>
<td><strong>Conglomerate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>11</td>
<td>1981–84</td>
<td>0.060</td>
<td>0.475</td>
<td>0.599</td>
<td>0.332</td>
<td>0.225</td>
<td>0.437</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.108</td>
<td>0.462</td>
<td>0.729</td>
<td>0.548</td>
<td>0.242</td>
<td>0.518</td>
</tr>
<tr>
<td>Medium</td>
<td>133</td>
<td>1981–84</td>
<td>0.140</td>
<td>0.532</td>
<td>0.958</td>
<td>0.552</td>
<td>0.186</td>
<td>0.559</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.080</td>
<td>0.578</td>
<td>1.342</td>
<td>0.658</td>
<td>0.179</td>
<td>0.704</td>
</tr>
<tr>
<td>Large</td>
<td>130</td>
<td>1981–84</td>
<td>0.078</td>
<td>0.432</td>
<td>0.696</td>
<td>0.452</td>
<td>0.112</td>
<td>0.476</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.090</td>
<td>0.470</td>
<td>1.078</td>
<td>0.675</td>
<td>0.166</td>
<td>0.649</td>
</tr>
</tbody>
</table>

Note: We classify an establishment as small if the number of workers during the first year of observation was 20 to 99, medium-size if the number of workers was 100 to 500, and large if the number of workers was greater than 500.

a. Capital stock includes land, buildings, machinery, equipment, and other items, at replacement value.
b. Gross of tax and depreciation.
c. Not including trade credit.

Source: Authors' calculations based on survey data. See appendix for details.

<table>
<thead>
<tr>
<th>Market orientation and size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Operating surplus gross of interest payments/capital stock (P/K)</th>
<th>Operating surplus net of interest payments/capital stock minus debt (S/Eq)</th>
<th>Stock of debt/capital stock (D/K)</th>
<th>Interest payments/stock of debt (i/D)</th>
<th>Value added/capital stock (VA/K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonexporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>742</td>
<td>1981–84</td>
<td>0.028</td>
<td>0.202</td>
<td>0.184</td>
<td>0.202</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.070</td>
<td>0.378</td>
<td>0.414</td>
<td>0.342</td>
<td>0.308</td>
</tr>
<tr>
<td>Medium</td>
<td>1,045</td>
<td>1981–84</td>
<td>0.072</td>
<td>0.325</td>
<td>0.439</td>
<td>0.440</td>
<td>0.180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.080</td>
<td>0.348</td>
<td>0.428</td>
<td>0.338</td>
<td>0.192</td>
</tr>
<tr>
<td>Large</td>
<td>582</td>
<td>1981–84</td>
<td>0.072</td>
<td>0.340</td>
<td>0.447</td>
<td>0.340</td>
<td>0.132</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.070</td>
<td>0.395</td>
<td>0.543</td>
<td>0.395</td>
<td>0.168</td>
</tr>
<tr>
<td>Exporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>35</td>
<td>1981–84</td>
<td>0.050</td>
<td>0.348</td>
<td>0.417</td>
<td>0.342</td>
<td>0.215</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.120</td>
<td>0.512</td>
<td>1.041</td>
<td>0.667</td>
<td>0.248</td>
</tr>
<tr>
<td>Medium</td>
<td>291</td>
<td>1981–84</td>
<td>0.082</td>
<td>0.348</td>
<td>0.636</td>
<td>0.605</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.098</td>
<td>0.475</td>
<td>0.925</td>
<td>0.600</td>
<td>0.175</td>
</tr>
<tr>
<td>Large</td>
<td>275</td>
<td>1981–84</td>
<td>0.038</td>
<td>0.285</td>
<td>0.670</td>
<td>0.698</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.060</td>
<td>0.530</td>
<td>2.260</td>
<td>0.805</td>
<td>0.135</td>
</tr>
</tbody>
</table>

**Note:** We classify an establishment as small if the number of workers during the first year of observation was 20 to 99, medium-size if the number of workers was 100 to 500, and large if the number of workers was greater than 500. "Exporting" refers to establishments that produce for export markets.

- a. Capital stock includes land, buildings, machinery, equipment, and other items, at replacement value.
- b. Gross of tax and depreciation.
- c. Not including trade credit.

*Source: Authors' calculations based on survey data. See appendix for details.*
the number of workers was 100 to 500, and large if the number of workers was greater than 500. The establishments were also classified into conglomerate and nonconglomerate categories: establishments that belong to a group of firms engaged in different types of activities are classified as conglomerates. The third categorization is whether the establishment directly exported any of its output in 1985. To see the effect of the 1983 financial liberalization on the behavior of individual establishments, the sample period was also divided into two subperiods: pre- and postliberalization (1981–84 and 1985–88, respectively). The year 1984 was chosen as a cutoff to allow for the 1983 liberalization to take effect.

To normalize variables for the scale of establishment, we have chosen to show investment and various financial flows as ratios in relation to the replacement value of the capital stock. In the tables that follow, we report average values of various ratios for different subgroups of establishments and subperiods of time. The ratios of interest include the ratio of gross investment to capital stock, which reflects expenditures for both replacement and expansion; the ratio of gross operating surplus before interest payments in relation to capital, which reflects the total returns to capital independent of financial structure; the ratio of gross operating surplus net of interest payments to own equity (measured as the value of capital stock minus debt), which reflects the profitability of equity holdings; the ratio of debt to capital, which captures the degree of leverage; and the ratio of value added to capital, which is a measure of capital intensity. We also show the ratio of total interest payments to total debt (excluding trade debt) as a measure of the average cost of borrowed funds for each type of establishment. The variations in this last ratio should reflect, in part, differential access to types of external finance.

The manufacturing sector in Indonesia was deeply affected by the 1983 deregulation along with the other structural reforms that were gradually implemented afterward. The abolition of credit ceilings, the curtailment of liquidity credits, and the elimination of most controls on interest rates had effects that differed systematically among establishments, depending on their specific characteristics as shown in tables 3, 4, and 5.

It is impossible to disentangle completely the effects of financial reforms from those of other factors that were influencing economic incentives and resource allocation in Indonesia during this period. But the pattern of changes is consistent with theoretical predictions of the consequences of financial reforms, where these judgments are based on changes in the average values of various ratios in the pre- and postreform periods. Table 3 shows that the cost of borrowing (interest payments over the stock of debt) rose on average by almost 22 percent, from 16.9 percent to 20.6 percent. At the same time, value added per unit of capital rose by more than 40 percent, and the investment rate increased by more than 25 percent. The profitability of investment (the ratio of operating surplus before interest pay-

3. Only a few establishments reduced or increased their number of workers sufficiently during the sample period to move the establishment to a different size category. Therefore we decided to use the first-year number of workers for categorization.
ments to capital stock) increased substantially, from gross returns of approximately 29 percent to 43 percent, which, of course, mirrored the marked increase in value added per unit of capital. Despite the higher interest rates, the degree of financial leverage in the industrial sector also increased. And the increases in profitability in relation to the increases in interest rates caused returns to equity (the ratio of operating surplus net of interest payments to capital stock minus debt) to rise even further, from gross levels of 42 percent to gross levels of 76 percent.

These rates of return appear implausibly high. They are obviously biased upward significantly by several factors. First, taxes and depreciation are not subtracted from the numerator. Second, the (substantial) value of working capital (inventories, accounts receivable, and holdings of financial assets) are not included in the denominator. However, our conclusions about the direction of change over time of rates of return, or about their relative values across different types of firms, are unlikely to be affected. Furthermore, it was clear from interviews conducted by Harris in 1988 that Indonesian manufacturing firms expect high rates of return. Entrepreneurs stated that they consider only investments with payback periods of two to two-and-a-half years.

For this constellation of outcomes to coexist in the aggregate, several different causal mechanisms may be operative. Increases in industrial profitability through exchange rate adjustments and relaxation of costly regulations and licensing systems can account for some of these changes. A higher cost of capital should lead to lower capital intensity and a higher marginal return to capital through factor substitution. In fact, there is about an 8 percent increase in the wage bill per unit of capital between the pre- and postliberalization periods, reflecting a similar increase in the use of efficiency units of labor. However, the increasing levels of investment and returns to equity associated with increased leverage are not consistent with an increase in the real interest rate in the context of a fully equilibrated capital market. These observations are consistent with results predicted when interest rate controls and administrative allocations are relaxed in a repressed system (Fry 1988, chap. 12–17). In those models, higher interest rates cause the volume of intermediated savings to increase, and the switch from administrative to market-based allocation increases the marginal efficiency of investment. Less productive establishments that had access to the “cheap” credit previously through administrative connections relinquish their claims to resources because of cost. In addition, there are a substantial number of liquidity-constrained entrepreneurs, who would potentially use the funds profitably and who are willing and eager to expand their investment once they gain access to credit, despite its higher cost.

According to table 3, the financial reforms appear to have had the greatest relative impact on small establishments. Although the interest rates faced by

4. Establishments we describe as “small” are classified as “medium” in the official Indonesian statistical system. In the official system the term “small” is reserved for enterprises with more than 5 and fewer than 20 employees. “Household” or “cottage” enterprises are the terms used to define the smallest units. The definition we use for “small”—a firm with 20 to 99 employees—conforms to standard international usage.
small firms were always higher than for larger firms, they increased relatively much more. Yet, small firms, facing the highest interest rates, experienced the greatest relative increases in their rate of investment, their leverage ratio (the ratio of stock of debt to stock of capital), and the productivity of their capital (value added and gross profit per unit of capital, both of which doubled). As a result, the returns to their own equity increased dramatically, tripling from 26 to 78 percent.

Medium-size establishments, which were already the most highly leveraged and most profitable, experienced a small increase in interest rates and actually decreased their levels of leverage. At the same time, the large firms, which had enjoyed significantly lower interest rates, faced a 40 percent increase in interest rates, to levels comparable to those faced by medium-size firms. These large firms also dramatically improved their profitability and productivity and increased their degree of leverage, with resulting large increases in returns to equity.

As one would expect, given the institutional structure of Indonesian manufacturing, conditions of access to credit vary considerably across the size classes, but these data suggest a considerable diminution of the variation among firms categorized by size. Although the interest rates were highest for small establishments and lowest for large establishments both before and after liberalization, the proportional spread between these rates decreased slightly after the reforms, and differences between medium-size and large establishments virtually disappeared. Rates of profitability and productivity converged relatively, as did the leverage ratios. The small establishments continued to have the lowest levels of leverage and returns to equity throughout the entire period, but the differences narrowed after the reforms. At the same time, the rate of investment increased for all types of establishments, but most for the small ones, and there was a degree of convergence in these measures as well.5

This picture is not inconsistent with one of less-well-connected small establishments benefiting from increased access to credit after reforms, albeit at higher interest rates. Also, the corresponding increases in cash flow, particularly for small firms, have substantially increased the capacity of firms to expand investment through self-financing, thereby making them less dependent on credit in the future.

If the sample is divided further between establishments that belong to a conglomerate and those that do not, more striking results appear. In table 4 the pattern is clear. For nearly every size category of establishment in each period, the conglomerate members consistently face lower interest rates, demonstrate higher returns to total assets and productivity of capital, have higher leverage ratios, and therefore show sharply higher returns to equity. They also sustain higher rates of investment.

5. Virtually all of the small establishments are in fact firms—the unit of analysis that would be most appropriate in considering questions of access to the credit system.
As emphasized in Hoshi, Kashyap, and Scharfstein (1991), one way to mitigate informational problems is to belong to a business group, such as the Keiretsu in Japan, particularly if the group owns or has special ties with a bank. Belonging to such a group will tend to reduce the wedge between the costs of internal and external finance. As a consequence, large establishments that are part of conglomerates tend to have much higher ratios of debt to equity and of debt to capital than do unaffiliated large establishments. Several studies of the Indonesian Economy (Nasution 1983, 1986; Ramli 1991) have indeed found that the low interest rates and generous credit policies before 1983 caused Indonesian companies in general to choose very high debt-equity ratios. Table 4 shows that this is particularly true for all medium-size establishments and for large ones belonging to conglomerates.

The previous arguments that we made on the basis of variations only by size of establishment continue to hold, and the conclusions about the disproportionate gains of small firms are strengthened. Looking at the patterns within organizational forms, it is clear that small firms grew the fastest and increased leverage and raised productivity and profitability the most, despite facing the highest interest rates. In general, there is a marked tendency for convergence of activity and profitability within each group. The relative advantage of conglomerate members in terms of interest rates, leverage, and productivity remains roughly constant across size classes.

The pattern of high profitability and high leverage among medium-size establishments is similar, whether or not the establishments are members of conglomerate groups. However, among large establishments, there are striking differences between conglomerate and nonconglomerate members. The conglomerates face lower interest rates, which we conjecture arise partly as a result of preferential access to priority credits in the prereform period and partly as a result of better access to cheaper offshore borrowing in the later period. They also have much higher rates of leverage and higher returns to assets. As a result, their return to equity is approximately three times as high as for the nonconglomerate establishments (1.47 compared with 0.47 in the recent period). As the figures indicate, the highest increases in postreform returns to capital were experienced by the small firms and large conglomerates, although all medium-size firms continued to enjoy the highest absolute returns. These differences among large establishments are also reflected in the differential rates of capital expansion through investment, which quite closely parallel the rates of profitability. These results are robust to the denominator chosen (capital or equity).

Before 1984, small establishments—those that we hypothesize were more likely to face financial constraints—indeed had leverage ratios much lower than did the medium-size and large firms. Small firms are characterized by relatively volatile earnings as well as a lack of access to formal credit markets and therefore are likely to pay higher interest rates in financially repressed economies. This hypothesis about the cost of borrowing is confirmed for the small firms in
the sample: they have the highest average nominal cost of debt, defined as total interest payments divided by the stock of debt. The high cost of debt in the prereform period, 27 percent, compared with the average bank lending rate, which was less than 15 percent, is probably a sign of a high share of credit being obtained in the informal credit markets.

Not all of these changes in profitability of assets, borrowing, and investment rates can be attributed solely to the program of financial reform. As was pointed out in previous sections, much of the impetus for the entire package of reforms was to increase incentives for non-oil exports. These measures included exchange rate realignments, special allocations and interest rates for export credits, trade reforms, and changed administrative procedures for customs and ports. Therefore, it is useful to further categorize the establishments in our sample by export orientation and size. This is done in table 5, which reports the same measures that appeared in tables 3 and 4.

Among both small and large establishments there is a dramatic difference between exporters and nonexporters. In both periods, the exporters faced lower interest rates, achieved higher leverage ratios, and had much higher returns to assets. Returns to equity, which were already quite high, rose further after liberalization. By contrast, among medium-size establishments, the lower interest rates and higher leverage of exporters did not translate into higher returns to equity in the prereform period, because of the considerably lower returns to, and productivity of, capital in these units. However, there was a dramatic shift in the postreform period among these medium-size exporters, which became substantially more profitable than comparable, nonexporting medium-size units.

Clearly, the changes in fortunes of the exporting firms owed more to the trade and exchange rate reforms, which substantially increased the relative profitability of exporting, than to the financial reforms themselves. The aggregate data on non-oil export expansion confirms the response of Indonesian industry, which became particularly strong after 1988 (Parker 1991: 12–14; Hill 1990a, 1990b). The small exporting establishments, which performed so well, seem to have continued to enjoy greater access to credit at lower rates than did nonexporters in both periods, although it can be argued that increased access to credit at higher rates probably allowed previously constrained small exporters to expand and increase their profitability.

Up to this point, the analysis on real and financial indicators for our panel of manufacturing establishments can be summarized as follows. For small establishments, the economic reform had a positive effect on their overall performance. Medium-size firms may have been adversely affected by the liberalization and their degree of leverage decreased. However, one must be cautious about this conclusion. Medium-size establishments were already highly leveraged and were enjoying large cash flows in the later period. It may also have been that entrepreneurs made rational decisions to reduce the risk of high leverage, although the evidence is incontrovertible that returns to equity were extremely high as a result of leverage. The interplay between the prudential
Table 6. Firms' Share of Debt and Value Added by Firm Size and Period, Indonesia, 1981–84 and 1985–88

<table>
<thead>
<tr>
<th>Size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Total debt</th>
<th>New debt</th>
<th>Value added</th>
<th>Domestic debt</th>
<th>Foreign debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>777</td>
<td>1981–84</td>
<td>0.062</td>
<td>0.040</td>
<td>0.068</td>
<td>0.085</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>1985–88</td>
<td></td>
<td>0.077</td>
<td>0.069</td>
<td>0.087</td>
<td>0.126</td>
<td>0.012</td>
</tr>
<tr>
<td>Medium</td>
<td>1,336</td>
<td>1981–84</td>
<td>0.384</td>
<td>0.529</td>
<td>0.375</td>
<td>0.434</td>
<td>0.326</td>
</tr>
<tr>
<td></td>
<td>1985–88</td>
<td></td>
<td>0.374</td>
<td>0.425</td>
<td>0.330</td>
<td>0.355</td>
<td>0.306</td>
</tr>
<tr>
<td>Large</td>
<td>857</td>
<td>1981–84</td>
<td>0.554</td>
<td>0.431</td>
<td>0.557</td>
<td>0.481</td>
<td>0.668</td>
</tr>
<tr>
<td></td>
<td>1981–88</td>
<td></td>
<td>0.549</td>
<td>0.506</td>
<td>0.583</td>
<td>0.519</td>
<td>0.682</td>
</tr>
</tbody>
</table>

Source: Authors' calculations based on survey data. See appendix for details.

behavior of banks and the demands for credit by highly profitable and rapidly expanding medium-size firms cannot be fully analyzed at this point. The investment data suggest that both small and large conglomerate establishments were able to increase their investment rates substantially. By contrast, medium-size establishments experienced only a small increase in their investment rate, despite their absolutely high rates of return. They also showed little improvement in their average capital productivity, whereas the other establishments nearly doubled theirs, albeit from much lower initial levels. Therefore, after liberalization the productivity levels among the various categories of establishments began to converge.6

The Distribution of Debt

Which establishments benefited and which suffered from the reallocation of credit following financial reform? Tables 6, 7, and 8 provide data on establishments' shares of the stock of debt, new debt, value added, and the stock of domestic and foreign debt when establishments are grouped according to size, organizational form, and market orientation. These tables give a picture of how concentrated the credit distribution is in Indonesia and how it has changed since financial reforms were introduced.

Before examining the data regarding the relative shares of credit obtained by different types of establishments, an important fact must be kept in mind. The total volume of domestic credit channeled through the banking system rose in real terms by almost 20 percent a year (see table 1), but foreign borrowing increased even faster for the establishments in our sample. Foreign borrowing, which during 1981–84 accounted for 17.4 percent of the total debt of these firms, increased to 22.2 percent of the total in 1985–88. Thus changes in relative shares of credit must be interpreted in light of the rapidly expanding total.

6. Cho (1988) suggests that this convergence indicates greater economic inefficiency. However, once risk and asymmetric information are taken into account, the question of efficiency becomes quite complex, and it deserves further research.
The new-debt variable, measuring the additional flows of debt accumulated by these existing firms during each of the periods to finance expansion, should be a more sensitive measure of the changing pattern of credit allocation. At first glance, it is evident that small establishments receive a small share of total debt under any of these measures and that large ones receive a disproportionate share. However, in judging the degree to which credit is concentrated, it is most reasonable to compare debt shares with value added shares in each of the two periods.

Comparing columns 1 and 3 in table 6, in both periods credit shares reflect value-added shares quite closely, although both small and large establishments receive slightly lower shares of new debt in relation to value added than do medium-size ones. However, both total and new-credit shares increase for small establishments at the highest proportional rate. It is clear from column 4 that small establishments enjoyed the greatest increase in domestic credit, their domestic debt rising from 8.5 to 12.6 percent. At the same time, the large ones gained substantially by increased use of offshore borrowing.

In the earlier discussion of the interest rate effects of the reform, Indonesian domestic credit ceased being a “bargain,” and therefore it became advantageous for firms with access to offshore borrowing to take advantage of the substantially lower interest rates in other countries. We argued that conglomerate firms

Table 7. Firms’ Share of Debt and Value Added by Organizational Form, Firm Size, and Period, Indonesia, 1981–84 and 1985–88

<table>
<thead>
<tr>
<th>Organizational form and size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Share of</th>
<th>Total debt (1)</th>
<th>New debt (2)</th>
<th>Value added (3)</th>
<th>Domestic debt (4)</th>
<th>Foreign debt (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonconglomerate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>766</td>
<td>1981–84</td>
<td>0.050</td>
<td>0.030</td>
<td>0.058</td>
<td>0.064</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.063</td>
<td>0.054</td>
<td>0.073</td>
<td>0.093</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>1,203</td>
<td>1981–84</td>
<td>0.308</td>
<td>0.438</td>
<td>0.272</td>
<td>0.295</td>
<td>0.130</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.229</td>
<td>0.326</td>
<td>0.208</td>
<td>0.229</td>
<td>0.090</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>727</td>
<td>1981–84</td>
<td>0.352</td>
<td>0.172</td>
<td>0.390</td>
<td>0.228</td>
<td>0.298</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.340</td>
<td>0.180</td>
<td>0.326</td>
<td>0.299</td>
<td>0.210</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,696</td>
<td>1981–84</td>
<td>0.710</td>
<td>0.640</td>
<td>0.720</td>
<td>0.587</td>
<td>0.433</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.632</td>
<td>0.560</td>
<td>0.607</td>
<td>0.671</td>
<td>0.291</td>
<td></td>
</tr>
<tr>
<td>Conglomerate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>11</td>
<td>1981–84</td>
<td>0.012</td>
<td>0.010</td>
<td>0.010</td>
<td>0.021</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.014</td>
<td>0.015</td>
<td>0.014</td>
<td>0.033</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>133</td>
<td>1981–84</td>
<td>0.076</td>
<td>0.091</td>
<td>0.103</td>
<td>0.139</td>
<td>0.196</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.145</td>
<td>0.099</td>
<td>0.122</td>
<td>0.126</td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>130</td>
<td>1981–84</td>
<td>0.202</td>
<td>0.259</td>
<td>0.167</td>
<td>0.253</td>
<td>0.370</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.209</td>
<td>0.326</td>
<td>0.257</td>
<td>0.220</td>
<td>0.472</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>274</td>
<td>1981–84</td>
<td>0.290</td>
<td>0.360</td>
<td>0.280</td>
<td>0.413</td>
<td>0.567</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.368</td>
<td>0.440</td>
<td>0.393</td>
<td>0.379</td>
<td>0.709</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on survey data. See appendix for details.
and firms with established exporting relations were far more likely to be able to borrow abroad. We now examine the process of credit allocation when establishments are disaggregated according to conglomerate and exporting status.

Table 7 demonstrates the striking differences in the responses of conglomerate and nonconglomerate units. Because the number of small establishments associated with conglomerates is minuscule, all of the findings for small establishments in Table 6 continue to hold. Medium-size and large nonconglomerate establishments experienced a decline in their shares of total debt and in value added, and medium-size firms experienced a decline in their share of new debt. However, both small and large nonconglomerate firms increased their share of domestic credit.

It is clear that firms in all size categories of conglomerates increased their share of value added, total debt, and new credit. However, medium-size firms had decreasing shares of domestic credit, and the entire expansion for total conglomerates was explained by their sharply increased share of the increasingly important foreign borrowing.

Table 8 reveals a similar picture when the establishments are classified according to whether they exported. Major economic reforms after 1985 were intended to stimulate non-oil exports. The success of the reforms is reflected in the increase in the share of value added by firms that did some exporting, the share rising from 54.3 to 63.6 percent. This is consistent with analysis of the rapid rise

<table>
<thead>
<tr>
<th>Market orientation and size of firm</th>
<th>Number of firms</th>
<th>Period</th>
<th>Total debt</th>
<th>New debt</th>
<th>Value added</th>
<th>Domestic debt</th>
<th>Foreign debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonexporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>742</td>
<td>1981–84</td>
<td>0.040</td>
<td>0.022</td>
<td>0.050</td>
<td>0.056</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.046</td>
<td>0.036</td>
<td>0.052</td>
<td>0.068</td>
<td>0.003</td>
</tr>
<tr>
<td>Medium</td>
<td>1,045</td>
<td>1981–84</td>
<td>0.244</td>
<td>0.306</td>
<td>0.202</td>
<td>0.278</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.182</td>
<td>0.191</td>
<td>0.130</td>
<td>0.180</td>
<td>0.096</td>
</tr>
<tr>
<td>Large</td>
<td>582</td>
<td>1981–84</td>
<td>0.205</td>
<td>0.156</td>
<td>0.205</td>
<td>0.289</td>
<td>0.300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.210</td>
<td>0.170</td>
<td>0.182</td>
<td>0.340</td>
<td>0.241</td>
</tr>
<tr>
<td>Total</td>
<td>2,369</td>
<td>1981–84</td>
<td>0.489</td>
<td>0.484</td>
<td>0.457</td>
<td>0.623</td>
<td>0.441</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.438</td>
<td>0.397</td>
<td>0.364</td>
<td>0.588</td>
<td>0.340</td>
</tr>
<tr>
<td>Exporting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>35</td>
<td>1981–84</td>
<td>0.022</td>
<td>0.018</td>
<td>0.018</td>
<td>0.029</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.031</td>
<td>0.033</td>
<td>0.035</td>
<td>0.058</td>
<td>0.009</td>
</tr>
<tr>
<td>Medium</td>
<td>291</td>
<td>1981–84</td>
<td>0.140</td>
<td>0.223</td>
<td>0.173</td>
<td>0.156</td>
<td>0.186</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.192</td>
<td>0.234</td>
<td>0.200</td>
<td>0.175</td>
<td>0.210</td>
</tr>
<tr>
<td>Large</td>
<td>275</td>
<td>1981–84</td>
<td>0.349</td>
<td>0.275</td>
<td>0.352</td>
<td>0.192</td>
<td>0.368</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.339</td>
<td>0.336</td>
<td>0.401</td>
<td>0.179</td>
<td>0.441</td>
</tr>
<tr>
<td>Total</td>
<td>601</td>
<td>1981–84</td>
<td>0.511</td>
<td>0.516</td>
<td>0.543</td>
<td>0.377</td>
<td>0.559</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1985–88</td>
<td>0.562</td>
<td>0.603</td>
<td>0.636</td>
<td>0.412</td>
<td>0.660</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations based on survey data. See appendix for details.
of manufactured exports (see Parker 1991), a process that has accelerated further after the end of the period for which we have data.

In the aggregate, exporters received increased shares of total and new credit, which arose from increasing shares of both domestic and foreign borrowing. These conclusions hold for every size category of exporting firms.

Looking at the nonexporters, both small and large establishments received increased shares of total, new, and domestic credit. The share of value added by small establishments in this category increased slightly, but the shares of both medium-size and large ones fell. The relative decline of all medium-size establishments in table 7 is clearly explained by the substantial declines experienced by medium-size units that did not export. In the previous section, it was shown that before deregulation those establishments were the most profitable and most leveraged. Afterward, however, their investment rates, profitability, and leverage ratios all declined in relation to other units. In table 8, it is evident that the share of value added and credit for nonexporting, medium-size establishments fell sharply according to any of the measures.

This analysis of credit allocation sheds more light on how financial reform appears to have had different effects on establishments with different characteristics. Small establishments, which previously lacked access to the financial system, benefited by improved access even at substantially higher interest rates. At the same time, the high cost of domestic credit encouraged firms with access to foreign financial markets to substitute cheaper, foreign credit. These were the firms that were unlikely to face informational asymmetries, namely, large conglomerates that owned banks and enjoyed direct relations with the offshore credit markets in Singapore and Hong Kong, and exporters with established overseas commercial relations. This diversion of demand for domestic credit by the well connected could have been a significant factor in allowing greater access to credit by less-well-connected establishments.

IV. An Econometric Analysis of the Effects of Financial Liberalization on Investment

Is there econometric evidence that liberalization has succeeded in relaxing financial constraints faced by individual establishments? We investigate this issue by estimating a simple form of the investment function for the panel of individual establishments. The specification is based on the following characterization of the underlying behavioral relations.

Firms increase their capital stock through investment in response to expected profit. Desired investment can be financed in a number of ways; borrowing from credit markets and retention of cash flow (internal finance) are the two most important sources of funds for expanding existing firms. If capital markets are perfect, and abstracting from taxes, firms will be indifferent between various sources of funds. They will finance their investment at a constant marginal cost that will be closely related to the risk-free market interest rate, and they will invest until the latter is equated to the expected marginal return to investment.
However, with a risk of bankruptcy, informational asymmetries, and contract enforceability problems, lenders may be willing to provide additional financing for investment only at increasing interest premiums. The premium charged will depend on the value of the firm's assets that can be used as collateral. We expect there to be a negative association between investment and the debt-to-capital ratio, because the divergence between the risk-free rate and the marginal cost of borrowing increases as the degree of leverage rises.

Moreover, if markets are segmented, so that some classes of firms have limited access to borrowing, some will be forced to rely on internally generated funds and may have to forego some desired investment because of financial constraints. In such cases, we expect levels of investment to be positively related to measures of cash flow. Cash flow is also likely to provide information about future profitability. However, if the information content of cash flow does not vary across firms or over time, differences in the size of its coefficient are likely to reflect the degree of tightness of financial constraints. In carrying out an empirical investigation of the importance of market segmentation and of the effects of financial reform, it is natural, therefore, to estimate investment as being determined by expected profitability (proxied by changes in output), the risk-free market rates of interest, the degree of financial leverage, and cash flow.

We also expect the coefficient on the degree of leverage to differ across firms and between periods. Because the coefficient reflects the premium above the safe rate that must be paid as the debt-to-capital ratio increases, it is likely that the coefficient will be larger for firms that are perceived as riskier and for which informational imperfections are more severe. Moreover, we expect that the premium will decrease after financial liberalization if banking intermediaries are more efficient than the curb markets in gathering information about borrowers and monitoring them. It is controversial whether this is indeed the case, and we hope our empirical results will shed some light on these issues.

We conduct our empirical analysis by estimating an unrestricted investment equation of the general accelerator type, to which we have added cash flow and the debt-to-capital ratio. In equation 1, \( I_{it}/K_{it-1} \) denotes the rate of investment, \( \Delta Y_{it}/K_{it-1} \) denotes the change in sales as a proportion of the capital stock, \( S_{it}/K_{it-1} \) denotes cash flow, and \( D_{it-1}/K_{it-1} \) denotes the debt-to-capital ratio. Both \( K_{t-1} \) and \( D_{t-1} \) denote stocks at the end of period \( t-1 \). The general specification for our regression equation is

\[
I_{it}/K_{it-1} = \alpha_1(\Delta Y_{it}/K_{it-1}) + \alpha_2(S_{it}/K_{it-1}) + \alpha_3(D_{it-1}/K_{it-1}) + \nu_{it}
\]

where

\[
\nu_{it} = \epsilon_{it} + \lambda_i + \eta_t
\]

and \( \lambda_i \) is a time-invariant, firm-specific effect; \( \eta_t \) is a common time effect; and \( \epsilon_{it} \) is the idiosyncratic component of the error term.

Equation 1 has been estimated in first differences to control for the firm-specific effects, using both ordinary least squares (OLS) and the generalized
method of moments (GMM) estimator. The GMM method provides consistent (and efficient) estimates when the regressors are endogenous, which is likely to be the case for our model (Arellano and Bond 1991). Appropriately lagged values of the regressors are used as instruments (see the note to table 9). The effects of changes in the basic risk-free interest rate are captured, along with all other macro conditions that vary over time, in the same way for all firms, by year-specific dummies that are included in all the specifications. The output term is meant to capture the expected change in demand for the firm's product. The equation has been estimated on an unbalanced panel of 523 establishments that have at least four years of complete data (including nonzero investment). Our goal is to assess whether access to external finance varies across firms and whether financial liberalization has succeeded in relaxing financial constraints.

To do this, we allow the coefficients on the regressors, in particular the ones on the financial variables, to differ across firms according to their size. The coefficients are also allowed to differ between the pre- and postliberalization periods.

The econometric results are summarized in table 9. Columns 1 and 3 contain the OLS estimates and columns 2 and 4 the GMM estimates that were obtained by allowing the effects of cash flow and debt to differ between small firms (employing fewer than 100 workers) and larger firms (employing 100 or more workers). $M_j$ is a dummy variable that equals 1 if the firm is small and 0 otherwise, so that, for instance, $(S_j/K_{t-1})M_j$ denotes the cash flow variable for small firms, and $(S_j/K_{t-1})(1 - M_j)$ the one for larger firms. The overall picture provided by the OLS and the GMM estimates is quite similar. Comparing the two sets of results reveals that the coefficients estimated by OLS are generally smaller in absolute value and less precisely determined, as one would expect with measurement errors in the variables. Thus we focus on the GMM estimates. The GMM results in column 2 support the notion that investment behavior differs substantially across different categories of firms. Small firms appear to rely more on internal funds, as shown by the larger and significant cash flow coefficient, a result consistent with the view that small firms are liquidity-constrained.

The lack of access to credit and a large premium for external finance caused by asymmetric information appears to describe well the situation faced by small firms, whose coefficient of the debt-to-capital ratio is negative and significant. The cash flow coefficient for larger firms is small and insignificant, a strong indication that internal funds are less important for larger firms. Also the coeffi-

7. The program DPD (dynamic panel data) has been used in the estimation (Arellano and Bond 1988).
8. For evidence on the differential effect of cash flow in industrial countries, see Fazzari, Hubbard, and Petersen (1988); Devereux and Schiantarelli (1989); Hoshi, Kashyap, and Scharfstein (1991); and Blundell and others (1992). See Tybout (1983) and Nabi (1989) for evidence of the importance of financial constraints as determinants of investment in Colombia and Pakistan, respectively. Finally, see Jaramillo, Schiantarelli, and Weiss (1993) for an analysis, using the Euler equation approach, of capital market imperfections and the effect of financial liberalization in Ecuador.
9. Firms are classified in only two size categories because a three-way split made the equation too complex, given the small number of observations in each cell. We cannot reject the hypothesis that the coefficient for the output term is the same across firms (or periods).
Table 9. **Econometric Results of the Investment Equation**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimates not allowing for the effect of financial liberalization</th>
<th>Estimates allowing for the effect of financial liberalization</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>OLS (1)</strong></td>
<td><strong>GMM (2)</strong></td>
</tr>
<tr>
<td>Growth in sales-to-capital ratio, $\Delta Y_{it}/K_{t-1}$</td>
<td>0.019</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>(1.70)</td>
<td>(4.71)</td>
</tr>
<tr>
<td>Cash flow for small firms, $(S_t/K_{t-1})M_t$</td>
<td>0.087</td>
<td>0.649</td>
</tr>
<tr>
<td></td>
<td>(2.00)</td>
<td>(2.83)</td>
</tr>
<tr>
<td>Cash flow for small firms (after liberalization only), $(S_t/K_{t-1})(1 - M_t)$</td>
<td>-0.022</td>
<td>-0.268</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Cash flow for large firms, $(S_t/K_{t-1})(1 - M_t)$</td>
<td>0.037</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Cash flow for large firms (after liberalization only), $(S_t/K_{t-1})(1 - M_t)$</td>
<td>-0.022</td>
<td>-0.268</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Debt-to-capital ratio for small firms, $(D_{t-1}/K_{t-1})M_t$</td>
<td>-0.026</td>
<td>-0.146</td>
</tr>
<tr>
<td></td>
<td>(-2.69)</td>
<td>(-3.14)</td>
</tr>
<tr>
<td>Debt-to-capital ratio for small firms (after liberalization only), $(D_{t-1}/K_{t-1})(1 - M_t)$</td>
<td>0.039</td>
<td>0.173</td>
</tr>
<tr>
<td></td>
<td>(2.59)</td>
<td>(9.81)</td>
</tr>
<tr>
<td>Debt-to-capital ratio for large firms, $(D_{t-1}/K_{t-1})(1 - M_t)$</td>
<td>0.127</td>
<td>0.336</td>
</tr>
<tr>
<td></td>
<td>(2.59)</td>
<td>(9.81)</td>
</tr>
<tr>
<td>Debt-to-capital ratio for large firms (after liberalization only), $(D_{t-1}/K_{t-1})(1 - M_t)$</td>
<td>-0.040</td>
<td>-0.022</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.00)</td>
</tr>
<tr>
<td>Year dummy variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984–85</td>
<td>0.058</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(-0.07)</td>
</tr>
<tr>
<td>1985–86</td>
<td>0.024</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.7)</td>
<td>(-0.19)</td>
</tr>
<tr>
<td>1986–87</td>
<td>0.065</td>
<td>0.029</td>
</tr>
<tr>
<td></td>
<td>(2.58)</td>
<td>(1.34)</td>
</tr>
<tr>
<td>1987–88</td>
<td>0.087</td>
<td>0.105</td>
</tr>
<tr>
<td></td>
<td>(2.77)</td>
<td>(4.22)</td>
</tr>
<tr>
<td>Wald test, $W_1$</td>
<td>25.83</td>
<td>62.78</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(9.96)</td>
</tr>
<tr>
<td>Wald test, $W_2$</td>
<td>-2.98</td>
<td>-3.35</td>
</tr>
<tr>
<td></td>
<td>N(0,1), $M_1$</td>
<td></td>
</tr>
<tr>
<td>Test for first-order serial correlation</td>
<td>-0.98</td>
<td>-0.23</td>
</tr>
<tr>
<td></td>
<td>N(0,1), $M_2$</td>
<td></td>
</tr>
<tr>
<td>Sargan test</td>
<td>29.87</td>
<td>37.19</td>
</tr>
<tr>
<td></td>
<td>(23)</td>
<td>(42)</td>
</tr>
</tbody>
</table>

**Note:** The dependent variable is the investment-to-capital ratio, $I_t/K_{t-1}$. Equations are estimated in first differences. Instruments used are lagged values (two or more periods) of $I_t/K_{t-1}$, $\Delta Y_t/K_{t-1}$, $S_t/K_{t-1}$, and $D_{t-1}/K_{t-1}$; the last two variables are appropriately interacted with $L_t$ and $M_t$. $t$-statistics are in parentheses (absolute values).

a. For all equations, year dummies (1985–84 to 1988–87) are also used as instruments. Instruments are used in their GMM(2,1) form. See Arellano and Bond (1988).

b. $W_1$: Wald test of joint significance of regressors (excluding year dummies) distributed as $\chi^2(m)$, where $m$ is the number of regressors. $W_2$: Wald test of joint significance of year dummies.

c. Sargan test for overidentifying restrictions, distributed $\chi^2(p)$, where $p$ equals the difference between the number of instruments and regressors.
cient of the debt-to-capital ratio is positive and significant for larger firms, contrary to what one would expect. This seems to suggest that, for larger firms, having a higher degree of leverage increases their ability to raise external funds. Having obtained debt in the past may act as a signal to financial intermediaries of firms' creditworthiness.

If we analyze further how the behavior of firms was affected by the financial deregulation in 1983, the story becomes even more interesting. Columns 3 and 4 in table 9 display the estimates of the effects of financial reform for different categories of firms. A dummy variable, \(L_1\), that equals 1 after liberalization and 0 otherwise, is interacted with the financial variables and is used to assess the change in the cash flow coefficient and in the coefficient of the debt-to-capital ratio for small and large firms after liberalization, compared with the prereform period.

Before liberalization, the extremely large and positive cash flow coefficient for the small firms supports the hypothesis that small firms depended more heavily on internal funds to finance their investment. They also faced an increasing cost of external funds while their leverage was increasing, as suggested by the negative sign of the leverage coefficient. After liberalization, small firms relaxed their dependence on internal funds. The cash flow coefficient decreases significantly, from 0.558 to 0.290. Moreover the coefficient of the debt-to-capital ratio for small firms becomes very small in the period after liberalization. All the equations include year dummies to capture changes in the overall macro conditions. This minimizes the risk that changes in the slope coefficients may simply capture business cycle effects.\(^\text{10}\)

For large firms the coefficient of cash flow is small and insignificant before liberalization and remains so afterward. The debt-to-capital coefficient is positive and does not change between the two periods for large establishments.\(^\text{11}\)

To better understand why the coefficient on the degree of leverage is positive for larger firms, we allow it to differ between larger firms that belong to a conglomerate group and those that do not (none of the small firms belongs to a conglomerate). We do not report the full results for lack of space. However, as we would expect in a world of asymmetric information, the leverage coefficient is negative and significant for larger individual firms. It is, however, positive and significant for larger establishments that are parts of conglomerates. It is unclear whether the degree of leverage reported for an individual subsidiary unit of a conglomerate should indeed increase the cost of borrowing, because assignment

\(^{10}\) We have also estimated the equations without year dummies, and the results are basically the same.\(^{11}\) In a set of additional regressions, we have allowed for a more general dynamic specification of the equation by including the lagged dependent variable and one additional lag for the regressors. The fundamental conclusions reached in this article remain the same. We have also included future profits as an additional explanatory variable. In this specification the coefficient for cash flow decreases in size, as one would expect. However, it remains significant for small firms. Large firms are more responsive to future profits before liberalization, but the response of firms of all sizes becomes quite similar after financial reform. See Harris, Schiantarelli, and Siregar (1992).
of a particular liability to a specific unit is arbitrary and should be recognized as such by lenders. The coefficient on cash flow for large establishments does not depend on their conglomerate status.

V. Conclusion

What general conclusions can we draw at this stage about the effects of financial liberalization on Indonesian establishments? The overall impression one obtains from the analysis of the real and financial indicators for the establishments in our panel is that the economic reforms had a favorable effect on the performance of smaller establishments. On the financial side, liberalization has helped to reallocate domestic credit toward smaller establishments. To the extent that large units were successful in substituting the more expensive domestic credit with cheaper foreign credit, this helped to release some domestic credit to establishments lacking such access. Although nominal and real interest rates have risen to very high levels, real returns to capital assets remain high and have increased substantially, particularly for small and medium-size exporting establishments.

At the same time, the total volume of intermediated credit has expanded very rapidly following the reforms. For all groups, higher rates of financial leverage have given rise to extremely high returns to equity. Medium-size establishments, both conglomerate and nonconglomerate, have had the highest rates of returns to capital, financial leverage, and returns to equity. However, after liberalization these highly profitable units, which were already highly leveraged, reduced their leverage somewhat and did not experience as high an increase in their rate of investment as other establishments. However, one must be cautious in inferring causality, because the rate of cash flow remained high in relation to the rate of investment, and it is possible that many of these firms grew by forming new establishments in addition to expanding existing units.

The econometric results obtained from estimating investment equations also suggest that in the preliberalization period small units were facing capital market imperfections in the form of liquidity constraints or a schedule of rising costs for external funds, and that such financial constraints were relaxed after liberalization. The cash flow variable became less important, and the premium on external finance decreased substantially.

The results presented here should be treated with caution, and therefore a few caveats are in order. The nature of our sample did not allow us to examine the effect of financial reform on new start-ups and micro firms with fewer than 20 employees. Moreover, financial liberalization in Indonesia has been an ongoing process that accelerated further at the end of the 1980s, and, given the time dimension of our panel, we were not able to evaluate the effects of these most recent developments. More definite conclusions may be reached when investigators have access to data covering a longer period, after the implementation of reform measures introduced late in 1988.
The overall conclusion that can be drawn from our investigation is that financial reforms have had a significant, positive impact on firms' real and financial choices. The process of shifting from an administrative allocation of credit toward a market-based allocation has increased borrowing costs, particularly for smaller units, but, at the same time, has widened access to finance and decreased the degree of credit market segmentation. From the standpoint of investment and rates of profit, the net effect appears to have been positive.

APPENDIX. CONSTRUCTION OF THE DATA

The data were taken from the Annual Survey on Manufacturing Establishments, conducted by the Central Bureau of Statistics since 1975. An additional data set, the 1986 Census of Manufacturing Establishments, proved useful because it contained data on capital stocks and exports. The number of establishments in the annual survey varied from 8,300 in 1975 to around 14,000 in 1988; 5,830 establishments in the 1986 census had complete data on capital stock.

We selected a sample of firms from the two sources as follows (see Gultom-Siregar 1992). Before 1981, data on financial sources were not available. For this reason we used a sample period that ran from 1981 to 1988. The 1981–88 survey has data on 4,400 firms, with complete data for at least three sequential years of output, and the census data cover 5,430 firms. Merging the 1981–88 survey with the 1986 census left 3,192 firms with observations in both data sets. We then constructed capital stock estimates by backcasting and forecasting the capital stocks, using the capital stock from the 1986 data as a benchmark (see below for details). Deleting establishments that had estimated negative or zero capital stocks and extreme outliers, and keeping firms that had at least three years of positive output and at least one year with positive investment, left 2,970 establishments. This is the sample used for the descriptive statistics in section III (tables 3 to 8).

Many firms reported zero investment in many years. We were unable to determine whether reporting of zero investment was in fact a nonresponse or if it represented a real observation of very low investment. Because there are substantial econometric problems associated with estimating panel-based investment functions with observations of zero investment, the econometric analysis included only those observations in which the investment level was positive for at least four consecutive years. By following this practice, we were left with an unbalanced panel of 523 establishments, which is the sample used in section IV.

Although both samples are still subject to sample-selection bias, it is reassuring that the results reported in this article do not vary in any significant way from results reported earlier (Harris, Schiantarelli, and Siregar 1992). Those results were based on a much more restricted sample of 249 firms that had eight consecutive years of positive investment. The robustness of results across our two samples gives reason to believe that the selection problems did not vitiate the results reported here. Table A-1 shows the distribution of establishments in
Table A-1. Distribution of the Samples Used

<table>
<thead>
<tr>
<th>Characteristics for establishments, by category</th>
<th>Sample for descriptive statistics</th>
<th>Sample for econometric analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of establishments</td>
<td>Percentage of total</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>777</td>
<td>26.1</td>
</tr>
<tr>
<td>Medium</td>
<td>1,336</td>
<td>45.0</td>
</tr>
<tr>
<td>Large</td>
<td>857</td>
<td>28.9</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonconglomerate</td>
<td>2,696</td>
<td>90.8</td>
</tr>
<tr>
<td>Conglomerate</td>
<td>274</td>
<td>9.2</td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonexport</td>
<td>2,369</td>
<td>79.8</td>
</tr>
<tr>
<td>Export</td>
<td>601</td>
<td>20.2</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td>2,461</td>
<td>82.9</td>
</tr>
<tr>
<td>Foreign or joint venture</td>
<td>509</td>
<td>17.1</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>2,505</td>
<td>84.3</td>
</tr>
<tr>
<td>Public enterprise</td>
<td>465</td>
<td>15.7</td>
</tr>
<tr>
<td>Total number of establishments</td>
<td>2,970</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note: Small establishments have fewer than 100 workers, medium-size establishments have 100 to 500 workers, and large establishments have more than 500 workers. Nonconglomerate refers to individual establishments. Export market refers to establishments whose products are exported directly. Domestic refers to establishments with 100 percent domestic equity; foreign or joint venture refers to establishments with any level of foreign-equity participation. Private refers to establishments with 100 percent private (nongovernmental) equity, and public enterprise refers to establishments with any level of central or regional government equity participation.

the two samples. The degree to which the distribution of firms according to characteristics is unaffected by the unbalanced nature of the sample is remarkable and explains why our conclusions have been robust to alternative samples based on different selection criteria.

**Capital Stock**

We used 1986 prices to construct the variable for real capital stock. Fortunately, the 1986 census data provided the replacement value of capital stock. The data on annual investment purchases were obtained from the annual survey, and a deflator for investment goods was used to convert the investment to a real level based on constant 1986 prices. We calculated the estimated capital stock using the perpetual inventory method. Our task was simplified because both sources have the data broken down into five components: land, building, machinery, vehicles, and other capital goods. The main advantage of this breakdown is that it enabled the assignment of different physical depreciation rates to each type of asset when constructing the capital stock estimates. The figure we used for total capital stock was the summation of those five variables net of
assets sold during the period. For each type of asset, capital stock estimates were constructed by the perpetual inventory method, as follows:

\[(A-1) \quad K_{it} = I_{it-1} + (1 - \delta_i)K_{it-1} - IS_t\]

where \(i\) is the \(i^{th}\) type of capital good, \(t\) is the time period, \(K\) is capital stock, \(I\) is investment, and \(IS\) is sales of existing capital goods. In choosing the real depreciation rates to be used \((\delta_i)\), we used information from an informal survey we conducted in 1990. On the basis of the information collected, we assumed that buildings depreciate by 0.033 annually, machinery by 0.10, vehicles by 0.20, and other equipment by 0.20. Land was not depreciated. Aggregating across the \(i\) types of capital goods, we obtained the establishment-specific capital stock measure \(K_t = \Sigma_i K_{it}\).

This method of backcasting and forecasting the capital stock has one important weakness in that it is possible to estimate a negative capital stock value whenever the investment in a particular year is much larger than the previously estimated capital stock. We eliminated all establishments in which the capital stock estimate became negative in any year, because that is an impossibility and can arise only from data errors or gross deviation of estimated from actual physical depreciation rates.

To ensure that the estimate for capital stock was reasonable, we checked for outliers. We found that some establishments reported extremely low or high ratios of capital to value added. We believe that a ratio of less than 0.30 or more than 6.00 is a sign of misreported or mismeasured capital or value added. Therefore, we eliminated from the sample establishments with ratios of capital to value added of less than 0.30 or greater than 6.00.

**Stock of Debt**

To construct the debt variable, we used information collected in a special survey of 40 establishments carried out by Siregar in 1990. Most of the firms replied to the question concerning the flow of new debt for a certain year by providing, instead, the figure for the stock of debt outstanding, which was in fact easier to find in their balance sheet. By checking the ratios of debt to capital, interest to debt, interest to value added, and capital to value added, we concluded that it was indeed very likely that most of the establishments provided stock measures instead of flow measures of debt. Moreover, on the basis of these ratios it was possible to identify firms that provided data on flow of debt in any year. For these observations we converted flow data to stock of debt by cumulating the flows.

Finally, approximately 20 percent of the establishments did not provide the debt figures, although they almost always provided data on interest payments. Again from the special 1990 survey, some multiplant establishments did not have the debt figures in their bookkeeping, although they did have the interest payments, mainly because all loans were handled by the head office, with only the interest payments charged to the establishments. To obtain an estimate of the stock of debt for these establishments, we first had to decide which interest rate
should be used to impute the level of debt. Considering that the average annual interest rates ranged from 5 percent for priority sectors to as high as 45 percent in the informal credit market, we decided to use the median interest rate of firms reporting interest rates within that range and to calculate it yearly for different sizes of firms. We then used this median rate to impute the debt levels for years in which the debt figure was missing but interest payments were reported. Finally, for the establishments having an interest-to-debt ratio outside the 0.050 to 0.450 range, we used interest payments and the median rates for that year in their size class to impute the debt figure.

REFERENCES

The word “processed” describes informally reproduced works that may not be commonly available through library systems.


The Scope for Fuel Substitution in Manufacturing Industries: A Case Study of Chile and Colombia

Diana L. Moss and James R. Tybout

This article analyzes plant-level panel data from Chile and Colombia to assess how manufacturers might respond to carbon taxes and other policies that induce substitution between clean and dirty fuels. Is producer flexibility linked with sector of activity, capital vintage, or rates of new capital formation? When adjustments in energy use occur, are they accomplished through changes in factor proportions for individual producers, changes in the output shares of producers within an industry, or changes in the relative production levels of different manufacturing industries? Patterns of energy use within and between industries show that fiscal policies can significantly influence the level and mixture of energy use among manufacturers.

To anyone who has visited Mexico City, Santiago, Beijing, or Bangkok, the problem of industrial pollution is obvious. But despite increasing concern, effective strategies for emissions control have yet to be designed and implemented. Eskeland and Jimenez (1990) cite the following barriers to efficient abatement policies: public sector budget constraints (which inhibit public spending on monitoring, enforcement, and cleanup); uncertainty regarding abatement costs or benefits (which complicates the evaluation of net social returns to alternative policies); distributive concerns (which make it difficult to impose significant adjustment burdens); and the influence of private interest groups (which can lead to serious loopholes and windfalls for politically powerful agents). In view of these barriers, Eskeland and Jimenez propose that “fiscal policies not directly linked to pollution damage or emissions—such as commodity taxes, subsidies, or public sector prices—can be efficient complements to direct instruments” (p. 6). Not only can such policies potentially generate revenue, but they are also more difficult to manipulate for political reasons and are relatively easy to administer. Because energy intensity and fuel choice are important determinants of air pollution, selective fuel taxes would be candidates for such—rather blunt—indirect instruments.

Diana L. Moss is with National Economic Research Associates, and James R. Tybout is with the Department of Economics at Georgetown University. This article was funded by the World Bank research project “Pollution and the Choice of Policy Instrument in Developing Countries” (RP 676-48). The authors thank Gunnar S. Eskeland, Luis Gutierrez, Emmanuel Jimenez, Mark Kosmo, David Wheeler, and three anonymous referees for comments; and Jane Lay for computing assistance.

©1994 The International Bank for Reconstruction and Development / THE WORLD BANK
Although appealing, the Eskeland-Jimenez strategy must be weighed against the possibility that technologies permit little fuel substitution within most industries, especially in the short run. If producers' flexibility is limited, changes in the relative prices of different types of energy are mainly redistributive and might put many firms out of business or at a serious competitive disadvantage in world markets.

This article is a first step toward evaluating the Eskeland-Jimenez perspective. Using plant-level panel data from manufacturing industries in Chile and Colombia, we address two fundamental issues.

- What do recent experiences in these countries suggest about the latitude for energy conservation and fuel substitution? Is producer flexibility linked with the sector of activity, capital vintage, or rates of new capital formation? More broadly, what can be said about the relative importance of technology and the economic environment in determining patterns of energy use?
- When adjustments in energy use take place, are they accomplished through changes in factor proportions for individual producers, changes in the output shares of producers within an industry, or changes in the relative production levels of different manufacturing industries? What do these adjustment patterns suggest about the effect of energy policy on the structure of production?

To a lesser degree, we also examine the relation between energy intensity and energy prices and the question of whether there is likely to be a tradeoff between various policy objectives (such as a sensible trade policy) and pollution abatement.

The novelty of this study is that it is based on plant-level panel data from Chile and Colombia. These data provide detailed information on the quantities and values of various fuels consumed by all establishments with at least 10 workers during 1979–85 for Chile and 1977–89 for Colombia. Hence, it is possible to construct much better quantity and price measures than have been used in analyses based on aggregated data. Moreover, given that plants can be tracked through time, the data allow us to decompose the behavior of sectoral aggregates into changes in individual plant behavior and changes in the mix of plants.

Section I describes the three sources of changes in industrial energy use. Section II examines descriptive statistics on industrial energy use in Chile and Colombia: first, we examine indexes of energy use for the manufacturing sector and for specific industries and document the effect of product mix on aggregate

---

1. We use "energy" to mean a (value-weighted) sum of energy sources such as fuels and electricity.
2. We use "producer" equivalently with "plant," and we use "industry" to mean specific subsectors of the manufacturing sector. Generally these are identified by a three-digit ISIC code.
3. In connection with an earlier research project on industrial performance (RPO 674–46), the data were provided to the World Bank by the Chilean National Statistics Institute (INE) and the Colombian National Department for Statistics Administration (DANE).
energy use. Then, we decompose intra-industry adjustments into changes in the output shares of plants (interplant adjustment) and changes in the energy intensity of individual plants (intraplant adjustment). Section III assesses temporal trends in energy prices to determine whether relative price changes have been associated with any of the dimensions of adjustment described above. Two earlier studies have already estimated various price elasticities of energy demand using our data (Engeland, Jimenez, and Liu 1991; Guo and Tybout 1993). We review their findings and relate them to observed adjustment patterns.

Section IV develops a simple error components model to evaluate sources of variation in patterns of fuel use across plants within each industry. We introduce industry-specific variables such as location, plant entry, and size, and attempt to account for any unexplained variation in expenditure shares and energy prices across plants. Section V concludes with general observations.

I. Dimensions of Adjustment

Changes in industrial energy use can be thought of as coming from one of three sources: changes in the interindustry mix of goods produced, changes in the intra-industry output shares of the producers, or changes in the intrafirm energy intensity of individual producers. Although little work has been done on intra-industry output shares, there is evidence that the other two dimensions of adjustment have been important sources of change in industrial countries. For example, with respect to the interindustry mix of goods, changes in the sectoral composition of manufacturing in the United States have significantly reduced the use of fossil fuels. This reduction has occurred as the "smokestack" industries—chemicals, coal, iron and steel, paper products, and petroleum refining—have given way to nonelectric machinery, electronics, and instruments (Doblin 1988). The net effect has been to reduce energy needs per unit of industrial production and to increase the importance of electricity as an energy source in relation to fossil fuels.

Intraplant adjustments in energy intensity have also been extensively documented in the industrial countries. These adjustments can take several forms. First, for a given capital stock, plants make short-run substitutions among labor, capital, materials, and energy in response to shocks in the factor and output markets. Second, over time, equipment is renewed. New technologies become embodied in firms' capital stocks, either through the wholesale replacement of equipment ("process innovation") or through the retrofitting of old capital. Process innovation is a major undertaking, typically accomplished in the long run, whereas retrofitting allows for substitution between capital and energy or between fuels, or both, in the shorter term. Examples of process innovation

include the displacement of blast furnaces by arc furnaces in the steel industry and of wet kilns by dry kilns in the cement industry (Sterner 1989). Examples of retrofitting include the installation of more efficient motors, the addition of heat exchangers to boilers, and the addition of combustion controls to existing equipment. Efficiency can also be enhanced in the short run with housekeeping measures such as cleaning or replacing flues, smokestacks, furnaces, and plant insulation.

To determine policy, it is important to know which of the three dimensions of adjustment have been significant and how much latitude each provides for response to changes in the incentive structure. The balance of this article is devoted to shedding light on these issues.

II. AN OVERVIEW OF PATTERNS OF ENERGY INTENSITY

Most analyses of industrial energy use in the semi-industrial countries have been based on data aggregated over plants and industries. Thus, there is no set of “stylized facts” about the patterns of energy use in plant-level panel data, and the resulting implications regarding the questions raised above. To help fill this void, we begin with an overview of the Chilean and Colombian data. All quantity and share measures are Laspeyres indexes constructed with plant-specific prices held constant at 1980 values, and all price measures are Laspeyres indexes constructed with plant-specific quantities held constant at 1980 values. (The appendix provides details.) We use these indexes, rather than Divisia indexes, to isolate pure quantity effects from effects that are a result of price variation. Of course, the cost of this approach is that 1980 prices become increasingly inappropriate weights over time.

Manufacturingwide Aggregates

To gain a general sense of the levels of, and variability in, fuel intensities, we start, in table 1, with time trajectories of the share of energy spending in total variable costs and in gross output. Real fuel use as a percentage of real variable costs varies from a high of 5.73 to a low of 4.46 in Chile and a high of 3.83 to a low of 3.30 in Colombia. One immediate implication of these relatively small shares is that, overall, manufacturing subsectors could absorb substantial fluctuations in fuel prices without large changes in operating profits. However, as will be seen shortly, a handful of subsectors are much more dependent on energy than the average numbers suggest.

Given that prices are held constant for our energy use indexes, the fluctuations reported in table 1 do not reflect revaluation effects. Rather, they reflect changes in the output shares of plants, entry, exit, or adjustments in energy intensity among incumbent surviving plants. Interestingly, energy intensity appears to be procyclical in Chile, where the correlation between fuel intensity and manufactur-

The correlation between total energy use and employment levels is 0.52 for the sample period 1979–85. However, in Colombia this correlation is −0.11. The contrast between these countries could reflect the fact that Chile underwent a major recession in the early 1980s that eliminated nearly one-third of its plants.

Two other contrasts between Chile and Colombia are noteworthy. First, Chile managed to conserve some energy during 1979–85, whereas Colombia did not. If electricity generated is produced with purchased fuels (as opposed to feedstocks), our measure of total energy use overstates actual use. This bias probably grows with time in Chile because self-generated electricity grows, so the actual reduction in energy use is probably more dramatic than is indicated by table 1. Second, even after this conservation effort, manufacturing remained more energy intensive in Chile than in Colombia. This partly reflects the importance of copper smelting, which is an energy-intensive subsector, in Chilean manufacturing. But comparisons by subsector reveal that, in many industries, Chile also uses more energy per unit of output than Colombia does. One reason may be that Chile has a much cooler climate. Differences in the policy regime and in the relative prices of energy may also be important. We cannot pursue the relative-price explanation without actual output prices for standardized units of products. Unfortunately, only price indexes are available.

Next we consider shares of specific energy sources in manufacturers' total spending for energy. (Details of the construction of these shares are in the appendix.) Results for Chile appear in table 2, and for Colombia, at a more aggregated level, in table 3. In both countries, spending for electricity—the most important source of energy—increases fairly steadily as a percentage of total spending for energy. Holding prices constant, electricity's share of total spending for energy in Chile went from 37 percent in 1979 to 45 percent in 1985; in Colombia, a milder increase, from 49 percent in 1977 to 52 percent in 1988, was registered. Interestingly, the movement toward electricity use in Chile was accomplished mainly through self-generation by manufacturing plants; the share for self-generated electricity rose from 6.5 to 11.1 percent of total spending for energy during the sample period. Colombian manufacturers, whose use of electricity increased much less, were already generating electricity accounting for about 11 percent of total energy spending in 1977, and the share remained around this figure for the entire sample period. Self-generation may allow feedstocks to be used as inputs in electricity production and by-product heat and steam from electricity production to be used as inputs in output production. If self-generation promotes energy efficiency (for example, by allowing the plant more flexibility in fuel purchases), it could account for the overall patterns in energy intensity found in table 1.

In the Chilean case, it was possible to disaggregate nonelectric energy sources by type of fuel. This exercise (table 2) reveals that the use of fuel oil dropped significantly during the sample period, by 1985 reaching about 80 percent of its 1979 share of total fuel use. However, diesel's share more than doubled between 1979 and 1982 before dropping back to its 1979 level by 1985. Also, among the
Table 1. Manufacturingwide Energy Intensity in Chile and Colombia, 1977–88

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of energy spending in total variable costs, SVC (percent)</td>
<td>—</td>
<td>—</td>
<td>5.29</td>
<td>5.73</td>
<td>4.89</td>
<td>5.02</td>
<td>5.09</td>
<td>4.69</td>
<td>4.46</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Ratio of total energy use to total output, SQ</td>
<td>—</td>
<td>—</td>
<td>3.88</td>
<td>3.98</td>
<td>3.41</td>
<td>3.43</td>
<td>3.73</td>
<td>3.70</td>
<td>3.61</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Colombia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of energy spending in total variable costs, SVC (percent)</td>
<td>3.50</td>
<td>3.30</td>
<td>3.30</td>
<td>3.56</td>
<td>3.81</td>
<td>3.83</td>
<td>3.82</td>
<td>3.81</td>
<td>3.58</td>
<td>3.68</td>
<td>3.48</td>
<td>3.45</td>
</tr>
<tr>
<td>Ratio of total energy use to total output, SQ</td>
<td>2.64</td>
<td>2.39</td>
<td>2.37</td>
<td>2.66</td>
<td>2.86</td>
<td>2.75</td>
<td>2.68</td>
<td>2.68</td>
<td>2.49</td>
<td>2.55</td>
<td>2.51</td>
<td>2.46</td>
</tr>
</tbody>
</table>

— Not available.

Note: The construction of SQ and SVC is discussed in the appendix.
Table 2. Manufacturing Energy Mix in Chile, 1979 and 1985 (percent)  

<table>
<thead>
<tr>
<th>Source of energy</th>
<th>Share of manufacturers' total spending for energy, SEk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1979</td>
</tr>
<tr>
<td>Electricity</td>
<td>37.20</td>
</tr>
<tr>
<td>Generated</td>
<td>6.52</td>
</tr>
<tr>
<td>Purchased</td>
<td>31.22</td>
</tr>
<tr>
<td>Sold</td>
<td>0.55</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>31.75</td>
</tr>
<tr>
<td>Diesel</td>
<td>8.52</td>
</tr>
<tr>
<td>Stone coals</td>
<td>4.55</td>
</tr>
<tr>
<td>Coke</td>
<td>0.38</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>1.67</td>
</tr>
<tr>
<td>Coal</td>
<td>2.39</td>
</tr>
<tr>
<td>Gasoline</td>
<td>3.30</td>
</tr>
<tr>
<td>Liquid gas</td>
<td>1.59</td>
</tr>
<tr>
<td>Paraffin</td>
<td>3.75</td>
</tr>
<tr>
<td>Other fuel</td>
<td>4.06</td>
</tr>
<tr>
<td>Piped gas</td>
<td>0.84</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Note: Construction of SEk is discussed in the appendix.

less important fuels, the use of two relatively dirty energy sources (stone coals and fuelwood) increased during the sample period, whereas the use of two relatively clean sources (gasoline and paraffin) declined. Combined, the former went from 6.2 percent of total fuel use to 11.7 percent; the latter went from 7.1 to 3.2 percent. The association between these patterns of change in fuel intensity and changes in relative prices will be examined below.

Overall, then, there is significant movement toward using electricity and away from using other fuels in both countries. Given that electricity is generated mainly by hydro power in both countries, this is presumably a desirable trend toward cleaner production. We also see considerable flexibility in the use of other fuels, especially stone coals and fuel oil. However, on the basis of tables 2 and 3 alone, we cannot tell whether these adjustments were accomplished at the cost of contraction or failure among plants using dirty fuels relatively heavily.

Table 3. Manufacturing Energy Mix in Colombia, 1977 and 1988 (percent)  

<table>
<thead>
<tr>
<th>Source of energy</th>
<th>Share of manufacturers' total spending for energy, SEk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1977</td>
</tr>
<tr>
<td>Electricity</td>
<td>48.88</td>
</tr>
<tr>
<td>Generated</td>
<td>10.71</td>
</tr>
<tr>
<td>Purchased</td>
<td>40.36</td>
</tr>
<tr>
<td>Sold</td>
<td>2.19</td>
</tr>
<tr>
<td>Other fuels</td>
<td>51.12</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Note: Construction of SEk is discussed in the appendix.
Accordingly, we now turn our attention to the industry- and plant-specific energy usage patterns that lie behind the aggregates in tables 1, 2, and 3.

**Industry-Specific Energy Intensity**

Table 4 presents energy intensities by subsector through time. There is dramatic cross-industry variation in the fuel intensity of production. Seven industries stand out as considerably more fuel intensive than the rest in both countries: paper, industrial chemicals, ceramics, glass, cement, iron and steel, and nonferrous metals. Moreover, it is not unusual to find that fuel intensities vary dramatically within industries over time. For example, as a percentage of real gross output, energy use in the industrial chemicals subsector drops from 9.2 to 6.2 in Chile (1979-85) and from 7.3 to 3.7 in Colombia (1977-88). Likewise, for glass, energy use drops from 13.6 to 8.0 in Chile, and from 15.3 to 7.9 in Colombia. Ceramics, however, becomes more energy intensive in Chile (rising from 7.3 to 11.4) and less energy intensive in Colombia (decreasing from 15.6 to 11.4).

Overall, 16 of the 28 Chilean industries and 16 of the 26 Colombian industries showed at least some reduction (from the beginning to end of the period) in energy use per unit of output. These changes are partly caused by capacity utilization effects, but it appears likely that longer-term shifts in the fuel mix have taken place during the sample period. Moreover, the fact that adjustment patterns are very country specific for some industries (paper, rubber, and ceramics) suggests that local economic conditions can play a potentially large role in determining energy efficiency.

Changes in the composition of energy sources are also substantial within some industries. Although the changes are too extensive to report here in their entirety, industry-specific series on shares of energy sources in total energy spending by manufacturers show that the Chilean apparel subsector goes from 35 percent electric to 60 percent electric during 1979-85, while the Colombian wood products industry goes from 35 to 61 percent electric over 1977-88. Also, nonmetallic mineral production goes from 21 percent coal and 25 percent stone coals to 1 percent coal and 46 percent stone coals. (Industry-by-industry figures are available from the authors.)

**Product Mix and Intra-industry Adjustments**

To determine the relative importance of changes in product mix and in intra-industry energy use in shaping the aggregate energy intensity of manufacturing, we begin with a simple decomposition.

**Aggregate energy use.** Let $S_{Qm}$, be total energy use expressed as a percentage of total output for subsector $m$ in year $t$, and define $\alpha_{mt} = Y_{mt}/\Sigma Y_{jt}$ as subsec-

---

6. The petroleum refining industry was omitted from the analysis for Colombia because of suspicious data.
Table 4. Energy Expenditure as a Percentage of Gross Output by Subsector in Chile and Colombia, Selected Years

<table>
<thead>
<tr>
<th>Industry</th>
<th>Chile 1979</th>
<th>Chile 1985</th>
<th>Colombia 1977</th>
<th>Colombia 1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>3.48</td>
<td>3.05</td>
<td>1.35</td>
<td>1.11</td>
</tr>
<tr>
<td>Beverages</td>
<td>1.80</td>
<td>1.48</td>
<td>2.01</td>
<td>1.89</td>
</tr>
<tr>
<td>Tobacco</td>
<td>0.18</td>
<td>0.26</td>
<td>0.29</td>
<td>0.93</td>
</tr>
<tr>
<td>Textiles</td>
<td>4.28</td>
<td>3.49</td>
<td>2.41</td>
<td>2.79</td>
</tr>
<tr>
<td>Apparel</td>
<td>1.29</td>
<td>0.71</td>
<td>0.67</td>
<td>0.52</td>
</tr>
<tr>
<td>Leather</td>
<td>2.33</td>
<td>2.21</td>
<td>1.82</td>
<td>1.55</td>
</tr>
<tr>
<td>Footwear</td>
<td>0.60</td>
<td>0.57</td>
<td>0.77</td>
<td>0.86</td>
</tr>
<tr>
<td>Wood</td>
<td>3.06</td>
<td>1.97</td>
<td>4.51</td>
<td>2.14</td>
</tr>
<tr>
<td>Furniture</td>
<td>0.78</td>
<td>1.01</td>
<td>1.22</td>
<td>0.94</td>
</tr>
<tr>
<td>Paper</td>
<td>7.67</td>
<td>8.07</td>
<td>4.91</td>
<td>4.81</td>
</tr>
<tr>
<td>Printing</td>
<td>0.98</td>
<td>1.35</td>
<td>0.59</td>
<td>1.59</td>
</tr>
<tr>
<td>Industrial chemicals</td>
<td>9.17</td>
<td>6.23</td>
<td>7.29</td>
<td>3.67</td>
</tr>
<tr>
<td>Other chemicals</td>
<td>1.15</td>
<td>1.03</td>
<td>0.83</td>
<td>0.73</td>
</tr>
<tr>
<td>Petroleum refining</td>
<td>1.19</td>
<td>0.28</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Petroleum products</td>
<td>4.79</td>
<td>5.13</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Rubber</td>
<td>3.86</td>
<td>2.36</td>
<td>1.98</td>
<td>1.96</td>
</tr>
<tr>
<td>Plastics</td>
<td>1.94</td>
<td>2.16</td>
<td>1.68</td>
<td>2.23</td>
</tr>
<tr>
<td>Ceramics</td>
<td>7.27</td>
<td>11.43</td>
<td>15.59</td>
<td>11.44</td>
</tr>
<tr>
<td>Glass</td>
<td>13.61</td>
<td>8.00</td>
<td>15.32</td>
<td>7.85</td>
</tr>
<tr>
<td>Cement</td>
<td>13.00</td>
<td>12.37</td>
<td>12.20</td>
<td>11.20</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>9.26</td>
<td>9.51</td>
<td>4.92</td>
<td>5.47</td>
</tr>
<tr>
<td>Nonferrous metals</td>
<td>6.03</td>
<td>6.14</td>
<td>2.83</td>
<td>3.15</td>
</tr>
<tr>
<td>Metal products</td>
<td>2.39</td>
<td>2.03</td>
<td>1.50</td>
<td>1.72</td>
</tr>
<tr>
<td>Nonelectric machinery</td>
<td>2.40</td>
<td>3.75</td>
<td>1.92</td>
<td>1.29</td>
</tr>
<tr>
<td>Electric machinery</td>
<td>2.06</td>
<td>1.70</td>
<td>1.12</td>
<td>0.93</td>
</tr>
<tr>
<td>Transport equipment</td>
<td>1.20</td>
<td>1.70</td>
<td>0.70</td>
<td>1.36</td>
</tr>
<tr>
<td>Professional equipment</td>
<td>3.13</td>
<td>2.54</td>
<td>1.35</td>
<td>0.84</td>
</tr>
<tr>
<td>Miscellaneous industries</td>
<td>1.44</td>
<td>2.25</td>
<td>1.64</td>
<td>1.28</td>
</tr>
</tbody>
</table>

n.a. Not applicable.

Note: Construction of energy expenditure as a percentage of gross output, $S_Q$, is discussed in the appendix.

$Y_m$'s share in total manufacturing output during year $t$, where $Y_{jt}$ is total output of subsector $j$. Then the aggregates in table 1 are related to their industry-specific counterparts by the identity $S_{Qjt} = \Sigma_m S_{Qmt}\alpha_{mt}$, and the change in manufacturingwide energy intensity between period $t - 1$ and period $t$ may be written as

$$\Delta(S_{Qjt}) = \Sigma_m \Delta S_{Qmt} \alpha_m + \Sigma_m \Delta \alpha_{mt} S_{Qmt}$$

where $S_{Qmt} = 1/2(S_{Qmt} + S_{Qmt-1})$ and $\alpha_m = 1/2(\alpha_{mt} + \alpha_{mt-1})$. The first term on the right side of equation 1 is a share-weighted sum of the changes in energy intensities of each industry, and the second term is an intensity-weighted

7. All variables are measured in constant prices.
sum of the changes in output shares of each industry.\textsuperscript{8} (Changes in intensity for entering and exiting plants are all set equal to zero.)

The individual elements of each sum are too numerous to report; here we focus on several key findings about the changes between the initial and final sample years. For Chile, recall from table 1 that the change in manufacturing-wide fuel use over the sample period was \( \Delta(SQ_m) = 3.61 - 3.88 = -0.27 \) percentage points, or about an 8 percent decline. Using the decomposition (the first term on the right-hand side of equation 1), we find that this decline reflected within-industry changes in energy intensity (holding output composition constant) of \( \sum_m \Delta SQ_m \alpha_{m} = -0.47 \) and that this decline in energy use was offset partly by shifts in production toward more energy-intensive products: \( \sum_m \Delta \alpha_{m} SQ_m = 0.20 \) (see table 5, row 1). So the Chilean manufacturing sector could have reduced its energy intensity almost twice as much if it had maintained its 1979 output mix. (Contrast this with the United States, where changes in output mix have tended to reduce energy intensity.) Nonetheless, effects within industries were dominant and in the direction of energy conservation.

The main subsector responsible for the drag on energy saving during 1979–85 was nonferrous metals, which in Chile is mostly copper. This industry, which rapidly expanded its share of output, is one of the most energy intensive, and it became more so during the sample period. Partly offsetting the drag on energy saving were petroleum refining (which produced a smaller share of industrial output and became more energy efficient) and ferrous metals (which produced a smaller share of output but did not become more energy efficient).

At the aggregate level, Colombian manufacturing exhibits a qualitatively similar pattern: the total change in energy intensity was \(-0.18\), but it would have been \(-0.39\) if output shares had not been reallocated toward relatively energy-intensive producers (see table 5, row 5). The most important energy savings came from the food subsector (which accounts for about 20 percent of total output and mildly improved efficiency) and the industrial chemical subsector (which accounts for about 6 percent of output and dramatically improved efficiency).

In summary, energy savings have been accomplished in both countries without scaling back the energy-intensive industries. To the contrary, these industries have apparently gained market share while there has been a secular trend toward increasing energy efficiency within industries (recall that important energy price shocks occurred before the sample periods). Energy-intensive subsectors have saved the most, possibly because they reap a relatively high return from doing so. And their growth may have partly reflected the relocation to Latin America.

\textsuperscript{8} Because changes in energy intensity (\( SQ \)) are weighted by averaged shares (\( \alpha_m \)) rather than base shares (\( \alpha_{m-1} \)), the magnitude of this component depends partly on changes in shares, and similar comments apply to the component describing share effects. Nonetheless, because it is a product of changes, this effect is in the second order of smallness. To see this, write equation 1 as \( \sum_m \Delta SQ_m [\alpha_{m, t-1} + 1/2 \Delta \alpha_m] + \sum_m \Delta \alpha_m [SQ_m, t-1 + 1/2 \Delta SQ_m] \). Also the difference in magnitude between our share effect and our intensity effect is the same as it would have been if base year weights had been used.
Table 5. Energy-Specific Decomposition of Changes in Energy Intensity in Chile, 1979–85, and in Colombia, 1977–88 (expressed as change in percentage of output)

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>Total change in energy intensity, $\Delta(SO_m)$</th>
<th>Output mix effect, $\Sigma_m \Delta a_m SO_m$</th>
<th>Within-industry effect, $\Sigma_m \Delta a_m a_m^m SO_m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile, 1979–85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-0.47</td>
<td>0.20</td>
<td>-0.27</td>
</tr>
<tr>
<td>Diesel</td>
<td>-0.05</td>
<td>0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.15</td>
<td>0.05</td>
<td>0.19</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>-0.42</td>
<td>0.12</td>
<td>-0.30</td>
</tr>
<tr>
<td>Colombia, 1977–88</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-0.39</td>
<td>0.21</td>
<td>-0.18</td>
</tr>
<tr>
<td>Electricity</td>
<td>-0.11</td>
<td>0.10</td>
<td>-0.01</td>
</tr>
<tr>
<td>Other fuels</td>
<td>-0.28</td>
<td>0.11</td>
<td>-0.18</td>
</tr>
</tbody>
</table>

of energy-intensive producers from the North. However, given that energy costs do not account for a large proportion of total costs in most industries, it is likely that other forces not related to energy have also been at work.

Decomposing particular energy sources. Thus far we have used our decomposition (equation 1) to study changes in aggregate energy intensity. We now apply the same methodology to study changes in the intensity with which each of the major fuels is used. This exercise will allow us to determine the relative importance of output mix effects and within-industry effects in accounting for the shift away from fossil fuels toward electricity that was documented in tables 2 and 3. Results for diesel, electricity, and fuel oil are presented for Chile in table 5, as is a decomposition of electricity use for Colombia.

Several patterns merit note. First, for fuels, both countries follow the pattern for aggregate energy use discussed above. In Chile, the use of diesel and fuel oil per unit of output decline by 0.03 and 0.30, respectively, and general fuel use per unit of output declines in Colombia by about 0.18. These are substantial drops, given that these ratios begin at 0.33, 1.23, and 1.35, respectively. Second, however, patterns of electricity usage evolved very differently in the two countries. Chilean industries tended to become more electricity intensive at the same time that the output mix shifted toward electricity-intensive products. (Most of this was caused by increased electricity intensity in paper and pulp and in nonferrous metals—16 of the 28 three-digit industries showed reductions in electricity intensity.) But Colombian producers were attempting to economize on electricity usage while an offsetting product shift was taking place. In the next section we return to the issue of whether contrasting electricity prices in Chile and Colombia might account for this pattern. Finally, as we saw with aggregate energy use, adjustments within industries dominate changes among industries in output shares, or, in other words, overall changes in energy use are qualitatively similar to changes within industries.
Intraplant, Compared with Interplant, Adjustment in Energy-Intensive Industries

Thus far, we have seen that energy-intensive subsectors need not contract in order to save energy overall. But the adjustment burden may still be high if these savings are accomplished by forcing out the most energy-intensive plants within each subsector. To see if this type of adjustment explains the trend toward energy conservation documented at the industry level in tables 4 and 5, we now reapply our decomposition (equation 1) industry by industry. For this exercise we reinterpret $SQ_{mt}$ to be the energy intensity of the $m$th plant, and $\alpha_{mt}$ to describe the $m$th plant’s share in industrywide output. Tables 6 and 7 report this decomposition for the relatively energy-intensive subsectors.

Many of the figures in table 6 are large in relation to the figures in table 5. This is presumably because industries that use energy most intensively have the most latitude for adjustment. Furthermore, in most instances adjustment within plants was a more important source of change than adjustments in the output shares of different plants. (The exceptions are iron and steel in both countries, nonferrous metals in Chile, and cement in Colombia.) The importance of adjustments within plants suggests that substantial changes in energy intensity may be feasible without forcing plants to shut down. In both countries, producers of glass and industrial chemicals provide dramatic examples of this type of adjustment. In Colombia, ceramics shows dramatic improvements in energy efficiency within plants; but in Chile, equally dramatic adjustments within plants go in the

Table 6. Industry-Specific Decomposition of Changes in Energy Intensity in Chile, 1979–85, and Colombia, 1977–88

(expressed as change in percentage of output)

<table>
<thead>
<tr>
<th>Industry</th>
<th>$\Sigma_m D(SQ_{mt})$</th>
<th>$\Sigma_m D\alpha_{mt}SQ_{mt}$</th>
<th>$\Delta(SQ_{t})$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chile, 1979–85</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>0.25</td>
<td>0.15</td>
<td>0.40</td>
</tr>
<tr>
<td>Industrial chemicals</td>
<td>-3.05</td>
<td>0.11</td>
<td>-2.94</td>
</tr>
<tr>
<td>Ceramics</td>
<td>4.33</td>
<td>-0.18</td>
<td>4.16</td>
</tr>
<tr>
<td>Glass</td>
<td>-5.48</td>
<td>-0.14</td>
<td>-5.62</td>
</tr>
<tr>
<td>Cement</td>
<td>-0.83</td>
<td>0.20</td>
<td>-0.63</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>-3.12</td>
<td>3.37</td>
<td>0.25</td>
</tr>
<tr>
<td>Nonferrous metals</td>
<td>-0.44</td>
<td>0.55</td>
<td>0.11</td>
</tr>
<tr>
<td>All industries</td>
<td>-0.47</td>
<td>0.20</td>
<td>-0.27</td>
</tr>
<tr>
<td><strong>Colombia, 1977–88</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td>0.25</td>
<td>-0.35</td>
<td>-0.10</td>
</tr>
<tr>
<td>Industrial chemicals</td>
<td>-2.26</td>
<td>-1.36</td>
<td>-3.62</td>
</tr>
<tr>
<td>Ceramics</td>
<td>-4.03</td>
<td>-0.11</td>
<td>-4.15</td>
</tr>
<tr>
<td>Glass</td>
<td>-7.05</td>
<td>-0.42</td>
<td>-7.47</td>
</tr>
<tr>
<td>Cement</td>
<td>-0.13</td>
<td>-0.86</td>
<td>-0.99</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>-0.02</td>
<td>0.57</td>
<td>0.56</td>
</tr>
<tr>
<td>Nonferrous metals</td>
<td>0.60</td>
<td>-0.23</td>
<td>0.31</td>
</tr>
<tr>
<td>All industries</td>
<td>-0.39</td>
<td>0.21</td>
<td>-0.18</td>
</tr>
</tbody>
</table>
“wrong” direction. Such contrast suggests that the economic environment can play an important role in determining adjustment patterns.

To complete our analysis of adjustment within industries, we disaggregate changes in the energy mix variables, industry by industry. (This exercise is done for Chile only; data do not permit analogous disaggregation for Colombia.) Results based on a variant of equation 1 are reported in table 7 for the three most important energy sources and the seven most energy-intensive sectors. Not surprisingly, we still find that most of the important adjustments are coming within plants, rather than through changes in market shares. This pattern is especially clear in the paper and industrial chemicals subsectors, both of which show dramatic shifts toward the use of electricity and away from the use of fuel oil. Iron and steel producers also shift away from using fuel oil.

What might explain intraplant shifts in the mix of energy inputs? Industrial energy is used mainly to generate heat (with boilers and furnaces) and to drive machinery. Energy applications of the latter type are most likely to account for short- and medium-run shifts toward electricity use: motors and compressors that run on different fuels can be swapped without wholesale replacement of equipment. This may explain why the heavily mechanical paper and pulp industry showed a substantial increase in the use of electricity during the sample period. However, in Chile much of the increased demand for electricity was met by self-generation, suggesting that additional forces were at work. Self-generation was concentrated in the paper and pulp, industrial chemical, and petroleum refining industries—the same industries that have shifted toward self-generation in the United States. As in the United States, technological change may have moved these subsectors toward cogeneration, which produces electrical power and useful thermal output, both of which have uses in these industries. Also, and perhaps more important, the increase in self-generation may have reflected better use of feedstocks—wood waste, blast furnace gases, and by-products of petroleum refining—as inputs for self-generation. The decline in fossil fuel consumption by the paper and pulp, industrial chemicals, and petroleum industries as self-generation increases supports this latter explanation.

In principle, high-temperature furnaces—used for melting, firing kilns, refining, reheating, and smelting—might also have accounted for some of the movement out of fossil fuels. These furnaces can be fueled with coal, coke, or electricity. Moreover, furnace technology has changed significantly in the past several decades, widening the menu of available equipment. (The advent of the electric arc furnace, used to melt scrap steel in minimills, is a notable example.) Substitution between electricity and fossil fuels is not possible, however, without major adjustments in capital stocks. This may explain why the use of coal and coke shows no clear tendency to decline during the sample period (table 2). There is, however, evidence of significant substitution within several industries during this period: the nonmetallic minerals industry shows a clear tendency to substitute stone coals, and (less dramatically) electricity, for coal, and the iron and steel industry shifts out of using petroleum products and into using coal.
Table 7. *Industry-Specific Decomposition of Energy Mix in Chile, 1979–85*  
(expressed as change in percentage of total energy)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Electricity</th>
<th></th>
<th>Fuel oil</th>
<th></th>
<th>Diesel</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within-plant effect</td>
<td>Between-plants effect</td>
<td>Total effect</td>
<td>Within-plant effect</td>
<td>Between-plants effect</td>
<td>Total effect</td>
</tr>
<tr>
<td>Paper</td>
<td>22.09</td>
<td>1.68</td>
<td>23.77</td>
<td>-27.54</td>
<td>8.89</td>
<td>-18.66</td>
</tr>
<tr>
<td>Industrial chemicals</td>
<td>15.25</td>
<td>4.01</td>
<td>19.26</td>
<td>-23.64</td>
<td>-4.67</td>
<td>-28.31</td>
</tr>
<tr>
<td>Glass</td>
<td>3.39</td>
<td>-1.04</td>
<td>2.35</td>
<td>0.72</td>
<td>2.73</td>
<td>3.45</td>
</tr>
<tr>
<td>Ceramics</td>
<td>-9.01</td>
<td>-0.24</td>
<td>-9.25</td>
<td>-1.24</td>
<td>0.44</td>
<td>-0.80</td>
</tr>
<tr>
<td>Cement</td>
<td>2.68</td>
<td>1.98</td>
<td>4.67</td>
<td>-0.64</td>
<td>-4.37</td>
<td>-5.01</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>1.56</td>
<td>-2.82</td>
<td>-1.26</td>
<td>-13.18</td>
<td>-0.72</td>
<td>-13.91</td>
</tr>
<tr>
<td>Nonferrous metals</td>
<td>0.78</td>
<td>6.09</td>
<td>6.17</td>
<td>7.81</td>
<td>-6.01</td>
<td>1.80</td>
</tr>
</tbody>
</table>
These changes may well reflect the installation of new furnace equipment at major plants.

Boiler applications were probably the least important in providing latitude for substitution between electricity and fossil fuels, but they may have accounted for much of the substitution among fossil fuels. Boilers are typically fired with coal, natural gas, or oil (technological factors make electricity very inefficient). In Chile, natural gas is not widely available, so most heating is presumably done with coal and oil. Even among fossil fuels, boilers are typically designed to use only one type of fuel, although dual-fuel boilers can be built. Hence, unless Chilean manufacturers anticipated significant changes in the relative costs of coal and oil, it is unlikely that the short-run changes we observe in the sample years in coal and oil intensities reflect boiler adjustments. However, some manufacturers may have switched boiler types or retrofitted for alternative fuels over the longer term.

III. Temporal Trends in Prices

We have mentioned several ways in which energy intensity and fuel mixtures can be adjusted, and we have found that, particularly within certain three-digit industries, considerable adjustment has taken place at the plant level. We now wish to determine whether strong relative price changes have been associated with these adjustments.

Tables 8 and 9 present our manufacturingwide Laspeyres price indexes for each fuel category. Several general observations are in order. First, in Chile the cost of energy rose almost 30 percent more than output prices for manufacturers during 1979–85. Similarly, in Colombia the cost of energy rose 36 percent in relation to the wholesale price index during 1977–88. These relative price changes may largely explain the observed overall reductions in energy intensity within plants (see table 6, column 1).

Second, although the cost of electricity rose less than the aggregate energy price index in Chile, the cost of electricity rose substantially more than the aggregate energy price index in Colombia. (This contrast was at least partly the result of pricing policies that favored residential over industrial users in Colombia.) Correspondingly, manufacturers shifted toward reliance on electricity in Chile and away from reliance on electricity in Colombia (see table 5, column 1). The shift toward electricity was sufficiently strong in Chile that electricity per unit of output rose for manufacturing overall, even as energy per unit of output fell.

Finally, further evidence of a negative association between prices and fuel intensity is apparent in the Chilean data, where we can isolate utilization patterns for the various fossil fuels. For example, the ascendance of stone coals from 4.55 percent of total fuel use in 1979 to 8.03 percent in 1985 (table 2) is matched by a relatively modest rate of growth in stone coal prices, especially through 1984. Likewise, the growth of coke's share in total fuel use through 1984 (from 0.38 percent in 1979 to 0.93 percent in 1984) mirrors a low rate of
Table 8. *Energy Price Indexes in Chile, 1979 and 1985*  
(1980 = 100)

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>1979</th>
<th>1985</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>95.7</td>
<td>327.3</td>
</tr>
<tr>
<td>Coal</td>
<td>57.4</td>
<td>298.6</td>
</tr>
<tr>
<td>Stone coals</td>
<td>73.1</td>
<td>303.0</td>
</tr>
<tr>
<td>Coke</td>
<td>88.1</td>
<td>467.3</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>73.8</td>
<td>418.1</td>
</tr>
<tr>
<td>Diesel</td>
<td>76.0</td>
<td>355.6</td>
</tr>
<tr>
<td>Gasoline</td>
<td>77.2</td>
<td>358.3</td>
</tr>
<tr>
<td>Paraffin</td>
<td>65.4</td>
<td>375.2</td>
</tr>
<tr>
<td>Liquid gas</td>
<td>64.0</td>
<td>365.2</td>
</tr>
<tr>
<td>Piped gas</td>
<td>62.0</td>
<td>327.4</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>108.5</td>
<td>364.7</td>
</tr>
<tr>
<td>All types of energy</td>
<td>69.2</td>
<td>351.6</td>
</tr>
<tr>
<td>Manufacturing WPI</td>
<td>74.7</td>
<td>296.7</td>
</tr>
</tbody>
</table>

*Note: All indexes except the manufacturing wholesale price index (WPI) are constructed from the annual industrial survey data as described in the appendix. The manufacturing WPI is taken from Banco Central de Chile (1986).*

Table 9. *Energy Price Indexes in Colombia, 1977 and 1988*  
(1980 = 100)

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>1977</th>
<th>1988</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>45.6</td>
<td>830.0</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>44.4</td>
<td>492.3</td>
</tr>
<tr>
<td>All types of energy</td>
<td>46.5</td>
<td>646.7</td>
</tr>
<tr>
<td>Manufacturing WPI</td>
<td>53.5</td>
<td>548.2</td>
</tr>
</tbody>
</table>

*Note: The indexes are constructed from the annual industrial survey data as described in the appendix.*

price increase through that year, and the precipitous drop in coke's share in 1985 (to 0.75 percent) is associated with extremely rapid inflation in coke prices. Similar remarks apply to diesel, which showed mild price increases and rapid growth in usage through 1982, then reversed on both counts in 1984 and 1985. (Diesel fuel is mostly imported in Chile; the dramatic price swings represent both a reduction in import barriers and a maxi devaluation.)

Can we conclude that producers are responsive to prices? Elsewhere, Ekeeland, Jimenez, and Liu (1991) use the Chilean data, aggregated up to the sector level for each of 13 regions, to econometrically estimate partial and total price elasticities of energy demand in several sectors.9 They find considerable responsiveness to prices, and, in particular, that the partial own-price elasticity of demand for electricity is −0.982. When the effects of electricity prices on total energy use are factored in, this elasticity becomes −1.203. Other energy

9. By "partial" we mean that these elasticities describe substitution among energy sources when total spending on energy is held constant. "Total" elasticities allow for the fact that changes in energy prices will affect aggregate spending on energy.
sources—especially diesel and gas—show even higher elasticities; only the demand for coal is unresponsive to price changes. (See Westley [1992] for a fairly comprehensive survey on the price elasticity of demand for electricity among Latin American manufacturers.)

Further evidence is provided by Guo and Tybout (1993), who estimate partial price elasticities using cross-plant variation in the Chilean data. They base their estimates on a variant of the maximum likelihood estimator developed by Lee and Pitt (1987). This estimator deals with the technical problem that any particular plant will use only one or several fuels out of the available set. In sectors where the Guo-Tybout model performs well, the results confirm that the partial price elasticities of demand for electricity are substantial: \(-1.36\) in bakeries, \(-0.498\) in meatpacking, and \(-0.401\) in metal products. Furthermore, in some sectors, substantially larger (negative) price elasticities are found for many fuels. For example, the price elasticity of demand for fuelwood is \(-1.80\), and the price elasticity of demand for “other fuels” (the residual third category) is \(-2.44\) in bakeries. For meatpacking the same two elasticities are \(-3.75\) and \(-1.24\), respectively. Finally, elasticities are found to depend very strongly on plant size because production technologies are nonhomothetic. For example, among bakeries the partial price elasticity of demand for electricity ranges from about \(-1.4\) for the smallest plants to about \(-2.5\) for the largest.

All of these results are consistent with our general thesis that price variation can influence energy use patterns among manufacturers, even in the relatively short term. However, price-quantity associations need not imply causation, and many alternative readings of the data are possible. For example, most manufacturing equipment is imported in these countries, and, to the extent that technological innovations are embodied in all new equipment, manufacturers might have been passively pulled toward energy conservation even without fuel price incentives.

IV. ERROR COMPONENTS ANALYSIS OF SOURCES OF VARIATION

By looking only at sectoral and industry-level summary statistics, we obscure the tremendous heterogeneity in patterns of fuel use across plants within each industry. This heterogeneity is potentially produced by cross-plant price variation, capital vintage effects, product differentiation, regional market effects, market power, and variation in productive efficiency. Having already considered price variation, this section looks at the remaining factors.

For our analysis of plant-specific variation in energy expenditure shares, we employ the following error components model:

\[
Z_{it} = \sum \alpha_m DT_{mt} + \sum \lambda_i DR_i + \sum \eta_k DI_{ik} + \theta_1 INCUMB_i + \theta_2 ENTRANT_i + \beta_1 SIZE_i + \beta_2 INVEST_i + \beta_3 T^* INVEST_i + \delta_i + \epsilon_{it}.
\]

The symbols in equation 2 are defined in table 10. We assume that \(\delta_i\) and \(\epsilon_{it}\) are orthogonal to all explanatory variables with a plant \(i\) subscript. This allows us
Table 10. The Error Components Model

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z_{it}$</td>
<td>One of the plant-level energy share measures of energy intensity (the share of a specific energy source in total energy spending, $SE_i$, or the share of energy spending in total variable costs, $SVC$).</td>
</tr>
<tr>
<td>$DT_{mt}$</td>
<td>Time dummy for period $m$ that takes a value of 1 when $m = t$, and 0 otherwise.</td>
</tr>
<tr>
<td>$DR_{ij}$</td>
<td>Location dummy that takes on value of 1 when plant $i$ is in region $j$, and 0 otherwise.</td>
</tr>
<tr>
<td>$DI_{ik}$</td>
<td>Industry dummy that takes a value of 1 if plant $i$ is a member of three-digit industry $k$, and 0 otherwise.</td>
</tr>
<tr>
<td>$INCUMB_{i}$</td>
<td>A dummy that takes a value of 1 if plant $i$ is present in all sample years, and 0 otherwise.*</td>
</tr>
<tr>
<td>$ENTRANT_{i}$</td>
<td>A dummy that takes a value of 1 if the $i$th plant enters the database during the sample years (and stays in).</td>
</tr>
<tr>
<td>$SIZE_{i}$</td>
<td>A measure of the size of the $i$th plant (the logarithm of its mean real output level).</td>
</tr>
<tr>
<td>$INVEST_{i}$</td>
<td>A measure of the rate of capital stock replacement (the log of the plant's mean investment level minus $SIZE$).</td>
</tr>
<tr>
<td>$T$</td>
<td>A time trend.</td>
</tr>
<tr>
<td>$\delta_i$</td>
<td>An unobservable (time-invariant) plant effect.</td>
</tr>
<tr>
<td>$\epsilon_{it}$</td>
<td>Remaining unexplained variation.</td>
</tr>
</tbody>
</table>

* The omitted class is plants that exit the database.

To use standard error components estimators to fit equation 2 and to isolate sources of variation in each plant-level index of fuel use. Unlike the sectorwide and industry-specific statistics discussed already, the error components results do not weight plants in proportion to their size. Hence, given that small plants are much more common than large plants, our findings in this section are driven mainly by the abundance of smaller plants.

Unexplained Variation and the Role of Prices

Table 11 presents our results explaining share in real expenditure for various fuel types. As discussed earlier, the dependent variables are calculated using plant-specific base year prices, so cross-plant variation reflects variation in both price and quantity. The most remarkable result in this table is that the variations in fuel shares across plants are mainly caused by unexplained plant effects and unexplained random noise. For example, in Chile, total sample variation in energy expenditure as a percentage of variable cost is 0.0082. Of this figure, 44 percent is attributable to variation in $\delta_i$, and another 49 percent is attributable to variation in $\epsilon_{it}$. Only the remaining 7 percent is explained by industry dummies, time dummies (not reported), plant size, location, incumbency, and rate of investment. Similar comments apply to Colombia, although 29 percent of the variation in energy expenditure as a percentage of variable cost is explained.
Table 11. Error Components Model of Real Expenditure Shares in Chile and Colombia

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Share of energy spending in total energy costs, SVC</th>
<th>Share of electricity in total energy spending, SEI</th>
<th>Share of energy spending in total variable costs, SVC</th>
<th>Share of electricity in total variable costs, SEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>0.001</td>
<td>0.006</td>
<td>−0.006</td>
<td>−0.016</td>
</tr>
<tr>
<td></td>
<td>(2.25)</td>
<td>(2.37)</td>
<td>(−6.52)</td>
<td>(−2.89)</td>
</tr>
<tr>
<td>City 1</td>
<td>−0.018</td>
<td>0.084</td>
<td>−0.049</td>
<td>0.152</td>
</tr>
<tr>
<td></td>
<td>(−7.70)</td>
<td>(9.02)</td>
<td>(−11.74)</td>
<td>(6.01)</td>
</tr>
<tr>
<td>City 2</td>
<td>−0.017</td>
<td>0.052</td>
<td>−0.056</td>
<td>0.259</td>
</tr>
<tr>
<td></td>
<td>(−4.41)</td>
<td>(3.53)</td>
<td>(−12.04)</td>
<td>(9.17)</td>
</tr>
<tr>
<td>Incumbent</td>
<td>−0.010</td>
<td>−0.010</td>
<td>0.011</td>
<td>−0.120</td>
</tr>
<tr>
<td></td>
<td>(−3.30)</td>
<td>(−8.32)</td>
<td>(2.99)</td>
<td>(−5.46)</td>
</tr>
<tr>
<td>Entrant</td>
<td>−0.005</td>
<td>0.013</td>
<td>−0.011</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>(−1.34)</td>
<td>(0.98)</td>
<td>(−2.68)</td>
<td>(1.59)</td>
</tr>
<tr>
<td>Investment/GDP, J/Q</td>
<td>0.001</td>
<td>−0.015</td>
<td>0.003</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>(2.63)</td>
<td>(−11.02)</td>
<td>(1.63)</td>
<td>(1.46)</td>
</tr>
<tr>
<td>Dependence of trend</td>
<td>−0.000</td>
<td>−0.000</td>
<td>0.000</td>
<td>−0.002</td>
</tr>
<tr>
<td>on investment/GDP, J/Q</td>
<td>(−0.66)</td>
<td>(−0.17)</td>
<td>(2.67)</td>
<td>(−3.34)</td>
</tr>
<tr>
<td>Variance of Unobservable plant effect, δ</td>
<td>0.004</td>
<td>0.063</td>
<td>0.001</td>
<td>0.043</td>
</tr>
<tr>
<td>Variance of Unexplained variation, ε</td>
<td>0.004</td>
<td>0.028</td>
<td>0.000</td>
<td>0.027</td>
</tr>
<tr>
<td>Energy share measure, Z</td>
<td>0.008</td>
<td>0.121</td>
<td>0.002</td>
<td>0.083</td>
</tr>
<tr>
<td>Mean Z value</td>
<td>0.039</td>
<td>0.607</td>
<td>0.033</td>
<td>0.649</td>
</tr>
</tbody>
</table>

Note: t ratios are in parentheses. For Chile, all equations are estimated with 29,231 observations. For Colombia, a random sample of 6,151 plants was used to save on computing costs. Time dummies and three-digit industry dummies are included in each regression but not reported. The city dummies represent Santiago and Valparaiso/Vina in Chile; Bogota and Medellin in Colombia. Dummies for six additional cities are included but not reported for Colombia.

Moreover, even if we limit our analysis to electricity, the explained portion of variation in real expenditure shares is only 25 percent in Chile and 16 percent in Colombia.12

These findings mean that there is tremendous within-industry heterogeneity in technologies (because of capital vintage effects and product heterogeneity) or that the economic incentives that influence fuel mixtures vary dramatically across plants within an industry (for example, because of regional fuel price variation or price discrimination) or that unexplained variation in base year

12. More detailed results on other energy sources for Chile are available from the authors. These results follow the same pattern. The reader may recall that dramatic cross-industry variation in energy intensities and fuel mixtures were reported in section I and may wonder why industry dummies do so little to explain variation in our error components model. The answer probably lies in the fact that the results in section I are dominated by the largest producers in each subsector, whereas the results in table 5 are dominated by the small (relatively common) plants.
(1980) prices across plants generates corresponding variation in expenditure shares, because these are measured in plant-specific base year prices.

We have no direct data on technologies, but price variation appears to be part of the story. A fourth possible explanation is measurement error problems. However, we view this as unlikely, given that the fuels are relatively homogeneous and the units of measurement are clearly defined in the survey forms. Further regressions (not reported) confirm that some of the cross-plant price variation is correlated with variables on the right-hand side of our error component model. So the coefficients in table 11 really represent an amalgam of technology, price, and other effects.

Explained Variation

What about explained variation in table 11? First, there is surprisingly little covariation of energy shares with plant size: \( t \)-statistics are small (given sample sizes) and the signs of the coefficients vary across countries. Bear in mind, however, that the reported regressions describe only the typical pattern of deviation from industry norms, because industry dummies control for industrywide size effects. Large plants in Chile generally rely more heavily on coal, diesel, fuel oil, and stone coals, whereas small plants rely much more heavily on fuelwood. Hence the incidence of fuel-specific taxes across the plant size distribution is likely to be far from uniform. (The strong nonhomotheticities in production technology that Guo and Tybout [1993] find with these data also imply unequal incidence.)

Also location matters. Plants in the major cities (Santiago and Valparaiso/Vina for Chile, Bogota and Medellin for Colombia) tend to be less energy intensive overall. In particular, these establishments rely relatively less on coal, coke, diesel, fuel oil, and stone coals and relatively more on electricity. So it appears that fuel mixtures are cleaner in the major cities, and less energy is used per unit of output. Several explanations for city effects are possible. First, although our industry dummies crudely control for product mix effects, goods manufactured in industrial centers probably differ from others within each of the three-digit industries. Second, fuel prices differ across regions, affecting both producer choices and the plant-specific price weights in our indexes. Finally, there may be complementarities between fuels and other factors (such as unskilled labor) that exhibit regional price and quality variation. To the extent that the latter two explanations hold true, the results in table 11 are another manifestation of the price sensitivity of fuel demands.

It is not possible to observe the age of plants in our data base, but we can distinguish plants that enter the data base during the sample period from those already in it. Given that the data cover all plants with at least 10 workers, these are either new plants or plants that have crossed the 10-worker threshold. As a first pass on the issue of vintage effects, we compare these to incumbents and to plants that exit the data base. (The latter are the omitted category.) Our results indicate that the three groups are not very different in terms of overall energy
intensity, although incumbents seem systematically less reliant on electricity than are entrants and exiting plants, both of which tend to be relatively young. On the one hand, this suggests an embodiment effect. On the other hand, aside from the association between rapid investment and low reliance on electricity in Chile, there is little evidence that plants that are replacing their capital stocks differ systematically from others in energy usage. (This observation holds also for the nonelectric energy sources.) So new capital equipment may not be necessary for adjustments in energy usage patterns.

V. CONCLUSIONS

Although we have not provided definitive answers to the questions we set out at the beginning of this article, we have reported several results that shed light on them. At the aggregate level, with respect to the latitude for changes in energy use, we found that Chilean manufacturers managed to mildly reduce the energy intensity of their production during 1979–85. Colombian manufacturing was less energy intensive on the whole, and its energy intensity decreased as well, albeit by a smaller amount than in Chile, during 1977–88.

More dramatically, Chilean manufacturers shifted away from fossil fuels and toward electricity. Both of these adjustments were primarily within plants rather than caused by changes in the mix of manufacturing goods produced. We see a different pattern in Colombia, where individual plants tended to become less electricity intensive during 1977–88, but where changes in the manufacturing output mix offset this tendency to economize on electricity. Generally, intra-industry and intraplant reductions in the use of fossil fuels and energy overall tended to dominate changes in the manufacturing output mix. Accordingly, it appears that substantial energy savings are possible without forcing widespread shutdowns among energy-intensive producers.

Combined with complementary studies on demand elasticities, our results suggest that the intra-industry adjustment away from electricity in Colombian manufacturing was probably caused in part by a rapid increase in the price of electricity during the period and that the adjustment toward electricity in Chile was probably partly the result of a fall in the price of electricity in relation to fossil fuels. Relative price changes for other fuels also matched changes in fuel intensities with surprisingly little lag.

In Chile, there is evidence that new capital equipment has embodied technologies that use electricity. First, much of the new demand for electricity was met with a secular trend toward self-generation; self-generation is not easily accomplished without new equipment. Second, new plants differed systematically in their energy usage from others of comparable size in the same industries. In both Chile and Colombia, new firms tended to rely more on electricity and much less on petroleum, than incumbents did. This suggests that new technologies were becoming embodied in the manufacturing capital stock through entry.

As for the incidence of energy taxes and subsidies, we found that energy use in Chile was concentrated in a handful of industries: food (because it is a big
subsector); copper (because it is big and energy intensive); and cement, industrial chemicals, iron and steel, paper, and petroleum (all of which are moderate in size and very energy intensive). The most important adjustments during the sample period came from petroleum refining (which became more energy efficient), iron and steel (which shrank), and copper (which grew while becoming less energy efficient). In Colombia, industrial chemicals, ceramics, glass, paper, cement, and iron and steel consumed the largest amounts of energy. The first three of these industries displayed the most significant adjustments, and the direction of these adjustments was similar to that in Chile.

Given these patterns of energy intensity, it is difficult to generalize about whether macro and trade policies are energy saving or energy using. Some products consistent with Chile's comparative advantage use considerable energy per unit of output. Copper and paper and pulp are prominent among these. However, it is not hard to find energy-intensive products among the import-competing subsectors (for example, industrial chemicals and iron and steel) or among nontradables (for example, cement). Patterns of fuel use across industries do suggest that taxes and subsidies designed to discourage reliance on "dirty" energy sources will have uneven incidence. For example, the brunt of adjustment to a tax on coal usage is likely to be concentrated in a few subsectors, such as iron and steel, and nonmetallic minerals.

In general, there is tremendous heterogeneity with respect to overall energy intensity and to fuel mixtures within each industry. Our error components model explained relatively little of the variation in fuel mixtures, but it did reveal that large firms rely relatively heavily on diesel, electricity, and fuel oil. Also, firms in the major cities (Santiago and Valparaiso/Vina in Chile; Bogota and Medellin in Colombia) are less fuel intensive overall and tend to rely relatively heavily on electricity; firms in other locations favor diesel and fuel oil. To the extent that these patterns reflect price variation across plant sizes and time, they provide further support for the conjecture that fiscal policies can significantly influence the level and mixture of energy usage among manufacturers.

Appendix. Data Preparation

The variables described below are the building blocks for our analysis. They are used to define and calculate the various quantity and price indexes and expenditure shares. (Details of missing data and outlier treatment are available from the authors.)

Chile

The panel of Chilean plants covers virtually all manufacturing establishments with at least 10 workers during 1979–85. For each plant and year, it includes data on electricity generated (volume), purchased (volume and value), and sold (volume and value), as well as on purchases of coal (volume and value), coke (volume and value), diesel (volume and value), fuel oil (volume and value),
fuelwood (volume and value), gasoline (volume and value), liquid gas (volume and value), paraffin (volume and value), piped gas (volume and value), stone coals (volume and value), and other fuels (value).

Colombia

The Colombian data span 1977–88, and, like the Chilean data, provide nearly comprehensive coverage of plants with more than 10 workers. However, these data do not disaggregate nonelectric energy use by category. The variables we observe at the plant level are electricity bought (volume and value), generated (volume), and sold (volume and value) as well as fuels and lubricants purchased (value).

Electricity is treated exactly as in the Chilean case: fuels and lubricants are deflated using fuel price deflators specific to each three-digit industry. The indexes were constructed by obtaining series from Colombia at the national level on coal, coke, diesel, and petroleum prices, then using the subsector-specific (three-digit industry) shares of these fuels from Chile as weights to construct Laspeyres price indexes, industry by industry.

The Variables of Interest

The symbol \( Q_{ijt} \) denotes the physical volume of energy source \( j \) consumed by plant \( i \) in year \( t \), \( V_{ijt} \) denotes the value expenditure by plant \( i \) on energy source \( j \) in year \( t \), and \( P_{ijt} = \frac{V_{ijt}}{Q_{ijt}} \) denotes the unit price for energy source \( j \) at plant \( i \) in year \( t \).

Quantity indexes. Real expenditure series were constructed using the unit price series. In turn, the real expenditure series were used to form Laspeyres quantity indexes for total fuel consumption at the plant, industry, or manufacturing level. For example, given \( J \) fuel types, our plant-level quantity index of total fuel use is

\[
LQ_{it} = \frac{\sum_{j=1}^{J} P_{j,80} Q_{ijt}}{\sum_{j=1}^{J} P_{j,80} Q_{j,80}}.
\]

Similarly, at the subsector level, our quantity index is

\[
LQ_{st} = \frac{\sum_{i=1}^{\pi} \sum_{j=1}^{J} P_{j,80} Q_{ijt}}{\sum_{i=1}^{\pi} \sum_{j=1}^{J} P_{j,80} Q_{j,80}}.
\]
Price indexes. Aggregating across fuels, we constructed plant-level Laspeyres energy price indexes:

\[ LP_{it} = \frac{\sum_{j=1}^{J} P_{jt} Q_{ij,t}}{\sum_{j=1}^{J} P_{jt} Q_{ij,t}}. \]  

Similarly, aggregating across fuels and plants, we arrived at subsectorwide energy price indexes:

\[ LP_{t} = \frac{\sum_{i=1}^{n} \sum_{j=1}^{J} P_{jt} Q_{ij,t}}{\sum_{i=1}^{n} \sum_{j=1}^{J} P_{jt} Q_{ij,t}}. \]  

Analogously, for the kth fuel alone, we constructed subsector-level Laspeyres price indexes:

\[ LP_{kt} = \frac{\sum_{i=1}^{n} P_{ik,t} Q_{ik,t}}{\sum_{i=1}^{n} P_{ik,t} Q_{ik,t}}. \]  

Expenditure shares. Finally, to document changes in fuel intensities, expenditures on each fuel were expressed as a fraction of several alternative aggregates: total fuel expenditures, total variable cost, and the gross value of output. Specifically, at the plant level, the share of energy source k in total energy use was constructed as

\[ SEK_{it} = \frac{P_{ik,t} Q_{ik,t}}{\sum_{j=1}^{J} P_{jt} Q_{ij,t}}. \]  

When aggregated to the subsector level, this measure of fuel intensity became

\[ SEK_{t} = \frac{\sum_{i=1}^{n} P_{ik,t} Q_{ik,t}}{\sum_{i=1}^{n} \sum_{j=1}^{J} P_{jt} Q_{ij,t}}. \]  

When energy use was expressed in relation to real variable costs (VC_{it}) or real gross output (Y_{it}), we obtained the plant-level measures of energy intensity \( SVC_{it} = \frac{P_{ik,t} Q_{ik,t}}{VC_{it}} \) and \( SQ_{it} = \frac{P_{ik,t} Q_{ik,t}}{Y_{it}} \) respectively, where both
VC and Y are expressed in 1980 prices. At the industry level, the numerators and denominators of these measures were summed over plants to yield

\[
(A-8) \quad SVC_i^k = \frac{\sum_{i=1}^{n} P_{ik,80} Q_{ik,t}}{\sum_{i=1}^{n} VC_{it}} \quad \text{and} \quad SQ_i^k = \frac{\sum_{i=1}^{n} P_{ik,80} Q_{ik,t}}{\sum_{i=1}^{n} Y_{it}}.
\]

When \( k \) superscripts are missing, the numerators of these measures have been summed across all \( J \) energy sources. For both countries, output was deflated using official three-digit gross output deflators. For Chile, the components of variable cost (fuels, intermediates, and labor) are each deflated separately, then aggregated to total variable cost. For Colombia, a single cost deflator was used.

REFERENCES

The word “processed” describes informally reproduced works that may not be commonly available through library systems.


How Robust Is a Poverty Profile?

Martin Ravallion and Benu Bidani

Comparisons of poverty, such as where or when poverty is greatest, typically matter far more for policy choices than do aggregate measures of poverty, such as how many people are deemed poor. We examine alternative methods for constructing poverty profiles, focusing on their internal consistency and appropriateness for guiding policy. None is perfect, but some methods appear to be preferable to others when the aim is to inform policies for fighting absolute-consumption poverty. A case study on Indonesia reveals that the country's regional and sectoral poverty profile is highly sensitive to some aspects of measurement but quite robust to others.

When practices in empirical work have a bearing on policy choices, they deserve especially close scrutiny. Constructing a poverty profile showing how the extent of poverty varies across subgroups of a population is typically the first step in formulating an antipoverty policy. Do the assumptions made matter to the policies advocated?

This article critically examines popular methods of constructing a poverty profile. We discuss the strengths and weaknesses of the two most common methods of setting poverty lines. Although neither is perfect, we argue that one of these methods is preferable when the poverty profile is intended to inform policies aimed at reducing absolute poverty.

Regional and employment profiles of poverty in Indonesia for 1990 are constructed by alternative methods to test the robustness of the poverty profile to the assumptions made. Section I discusses the alternative approaches in the abstract. Section II then describes the approach we have adopted as the benchmark for comparison purposes. The empirical results for Indonesia are discussed in section III. Our conclusions are summarized in section IV.

I. TWO STANDARD APPROACHES TO CONSTRUCTING A POVERTY PROFILE

A poverty profile shows how a measure of poverty varies across subgroups of a population, such as region of residence or sector of employment. Typically,
people in each subgroup are classified as poor if their consumption expenditure is below a specific poverty line for that subgroup. Poverty lines can thus be interpreted as deflators that establish the welfare comparability of nominal expenditures (or incomes) across the poverty profile.

How should one set poverty lines? When the aim is to inform policy, one appealing criterion is that whether or not a given standard of living constitutes poverty should not depend on the subgroup to which the person with that standard of living belongs. A poverty profile is considered consistent if it respects this principle. For example, suppose we are comparing two households deemed to have exactly the same standard of living in all relevant respects but located in different regions; the poverty profile would be inconsistent if it classified one of these households as poor and the other as not. Consistency requires that the poverty line be fixed in terms of the level of living implied.\(^1\) To test consistency, we must specify a measure of the standard of living; a poverty profile may be consistent in terms of one measure but inconsistent in terms of another. We shall follow convention in assuming that the poverty profile should reveal differences in command over basic consumption needs.

The appeal of this type of consistency may be at odds with another idea that is often desirable: that the choice of the basic-needs bundle should reflect local perceptions of what constitutes poverty in each subgroup. For brevity, let us call this specificity. Specificity may be interpreted as either a separate goal of basic-needs consistency or as another way to define consistency, by which the measure of individual well-being is broadened to include feelings of relative deprivation. For example, Sen (1987) defines poverty as the lack of certain capabilities, such as being able to participate with dignity in society. The capabilities are absolute, but the commodities needed are relative.

There is evidence of such specificity. Studies of subjective poverty lines reveal systematic relations between perceptions of what constitutes poverty and characteristics of the perceiver (Kapteyn, Kooreman, and Willemse 1988). There is also a strong positive relation between country poverty lines and average consumption across countries (Ravallion, Datt, and van de Walle 1991). Indeed, among industrial countries it is not uncommon to find poverty lines that have an elasticity of unity with respect to the average standard of living, in which case most poverty measures will be independent of absolute levels of living, but will depend entirely on relative inequalities.\(^2\)

Clearly, there can be a conflict between consistency and specificity. Basic-needs consistency requires that the poverty lines used imply the same command over basic needs within the domain of the poverty profile; the poverty lines may well be alien to the average standards of living of some subgroups. In proposing

---

1. Consistency also has implications for the properties of the functional form of a poverty measure, although that is not our concern here (see Foster and Shorrocks 1991).
2. This holds for all poverty measures that are invariant to scale, in that the measure is homogeneous of degree zero in the poverty line and the mean; see Ravallion (1993) for further discussion.
basic-needs consistency as a test for a poverty profile, we do not claim that this is all that matters. If one is after a purely descriptive account of poverty incidence by local perceptions, such consistency will have little appeal. However, one can readily imagine other circumstances in which an insistence on respecting the specificity of local poverty lines could yield absurd policy implications. For example, although the official estimates of poverty incidence in the United States and Indonesia around 1990 are at about the same level (14 to 15 percent of the populations are deemed poor), one would be loath to say that aid from the United States to Indonesia should thus cease; there are clearly many people who are not deemed poor in Indonesia who would be considered so in the United States. The measurement choice must ultimately rest on the purpose of the poverty profile.

The Cost of Basic Needs

We follow common practice in taking poverty to mean a lack of command over basic consumption needs, and the poverty line to be the cost of those needs. One method of implementing this definition is to stipulate a consumption bundle considered adequate for basic consumption needs and then to estimate its cost for each of the subgroups being compared in the poverty profile. This is the approach of Rowntree (1901) in his seminal study of poverty in York in 1899. It has been followed since in a number of studies for both industrial and developing countries, such as Thomas’s (1980) work on the regional poverty profile in Peru. We call this the cost-of-basic-needs (CBN) method of setting poverty lines.

The CBN method can be interpreted in two quite distinct ways. It can be interpreted as the cost of utility, although only under quite special assumptions about preferences. Using the cost of a given basic-needs bundle as the cost of utility requires assuming that utility-compensated substitution effects are zero. That is a restrictive assumption, although possibly less so for the poor. If it holds, then the estimated CBN, normalized by its value for some reference, is a utility-consistent cost-of-living index. (On such indexes see, for example, Deaton and Muellbauer [1980].) Under the second interpretation, the definition of basic needs is deemed to be a socially determined normative minimum for avoiding poverty, and the cost of basic needs is then closely analogous to the idea of a statutory minimum wage rate. No attempt is made to assure that utility rankings and poverty rankings coincide under this interpretation; a person might (for example) be deemed poorer in state A than state B even if the person prefers A to B.

In practice, the idea of respecting consumer choice has still influenced the second interpretation of the CBN approach in important ways. The criterion for defining poverty is rarely that one attains too little of each basic need. (Undernutrition is viewed as distinct from poverty.) Rather, it is that one cannot afford the cost of a given vector of basic needs. The definition of “afford” may or may not respect consumer choice. Early attempts to determine the minimum cost of achieving the basic-needs vector at given prices ignored preferences. However,
the resulting poverty lines were often so alien to consumer behavior that their relevance as a basis for policy was doubtful; see Stigler's (1945) estimates of the minimum cost of a nutritionally adequate diet. Instead, current practices aim to anchor the choice more firmly to existing demand behavior. Among the (infinite number of) consumption vectors that could yield any given set of basic needs, one is chosen that is consistent with choices actually made by some relevant reference group. Poverty is then measured by comparing actual expenditures to the CBN. A person who consumes less food (say) than the stipulated basic needs is not considered poor if the person's budget allocation could be rearranged to cover the basic needs.

Spending to Reach Basic Food Needs

Implementation of the CBN method poses a number of problems. A degree of arbitrariness in defining basic needs is inevitable, although it is not obvious that consistent poverty rankings will be affected much by the definition of basic needs. Another problem is that cross-sectional (and sometimes even intertemporal) price data are incomplete or unreliable; this is particularly problematic for nonfood goods. Achieving consistency, even in terms of the most basic consumption needs, may then be difficult.

A popular method of setting poverty lines tries to avoid these problems while still anchoring the poverty line to the most basic consumption need: food energy requirements. The main alternative to the CBN method is the food-energy-intake (FEI) method. This method proceeds by finding the consumption expenditure or income level at which a person's typical food energy intake is just sufficient to meet a predetermined food energy requirement. The method has been used in numerous countries (see Dandekar and Rath [1971], Osmani [1982], Greer and Thorbecke [1986], Paul [1989], Ahmed [1991], and Ercelawn [1991]).

The FEI method also aims to measure consumption poverty, rather than undernutrition. To measure undernutrition, one would simply look at nutrient intakes in relation to requirements, not at incomes or consumption expenditures. Like the CBN method, the FEI method aims to find a monetary value of the poverty line at which basic needs are met.

In practice, both methods anchor the definition of basic needs to food energy requirements. Setting those is itself problematic because requirements vary across individuals and over time for a given individual. An assumption must also be made about activity levels, which determine energy requirements beyond those needed to maintain the human body's metabolic rate at rest. However, this issue takes us beyond our present scope. (For an attempt to deal explicitly with the implications of unobserved variability in nutritional requirements, see Ravallion [1992].) We shall follow common practice in assuming that a single nutritional requirement for a typical person is already set. For the present inquiry, the

3. There is also an issue about whether the comparison should use expenditures or incomes; see Ravallion (1993).
key difference between methods is how the food energy requirements are mapped into the expenditure space.

In this respect, the FEI method is computationally far easier than the CBN method. A common practice is simply to calculate the mean income or expenditure of a subsample of households whose estimated caloric intakes are approximately equal to the stipulated requirements. More sophisticated versions of the method use regressions of the empirical relation between food energy intake and consumption expenditure. These can be readily used (numerically or explicitly) to calculate the FEI poverty line. Figure 1 illustrates the FEI method for two stylized subgroups: urban and rural. Food energy intake is plotted against total consumption expenditure. A rising line of best fit within each sector is indicated; this is the expected value of caloric intake at a given value of total consumption. Inverting this line produces the total consumption expenditure at which a person typically attains the stipulated food energy requirement within each sector. The method automatically includes an allowance for both food and nonfood consumption—thus avoiding the tricky problem of determining exactly the basic needs for these goods, as long as one locates the total consumption expenditure at which a person typically attains the caloric requirement. It also avoids the need for price data; in fact, no explicit valuations are required. Thus the method

4. Some versions of the FEI method regress (or graph) nutritional intake against consumption expenditure and invert the estimated function; others avoid this step by simply regressing consumption expenditure on nutritional intake. These two methods will not generally give the same answer, although the difference is not germane to our present interest; either way, the following points apply.
has a number of practical advantages, as proponents have noted (Osmani 1982; Greer and Thorbecke 1986; Paul 1989).

Ostensibly, then, the FEI method offers the hope of constructing a poverty profile consistent with the attainment of basic food needs, and of doing so with relatively modest data requirements. But if we are to use this method to inform policies aimed at reducing poverty in terms of basic consumption needs, we must also ask how closely the FEI method will approximate a consistent poverty profile, in that people with the same command over those needs are treated the same way.

The relation between food energy intake and total consumption expenditure is unlikely to be the same across the domain of any poverty comparison. Rather, it will shift according to differences in tastes, activity levels, relative prices, publicly provided goods, or other determinants of affluence besides consumption expenditure. And there is nothing in the FEI method to guarantee that these differences would be considered relevant to poverty comparisons. The following are examples.

- To the extent that prices differ between urban and rural areas (say, because of transport costs for food produced in rural areas), different nominal poverty lines should be used. However, relative prices can also differ, and (in general) this will alter demand behavior at given real expenditure levels (nominal expenditures deflated by a suitable cost-of-living index). For example, the prices of some nonfood goods tend to be lower in relation to foods in urban areas than in rural areas, and retail outlets for nonfood goods also tend to be more accessible (so the full cost, including time, is even lower) in urban areas. This may mean that the demand for food and (hence) food energy intake will be lower in urban areas than in rural areas at any given real expenditure level. But this does not, of course, mean that urban households are poorer at a given expenditure level.

- Activities in typical urban jobs tend also to require fewer calories to maintain body weight than do rural activities; the stipulated food energy requirements differ for activities such as agricultural labor and factory work (World Health Organization 1985). Again, food intakes will tend to be lower for urban workers at a given real expenditure, but this should clearly not be taken as a sign of poverty.

- Tastes may differ systematically. At given relative prices and real total expenditures, urban households may simply have more expensive food tastes; they eat more rice and less cassava and more animal protein and less food-grain, or they simply eat out more often. Thus urban households pay more for each calorie, or (equivalently) their intake of food energy will be lower at any given real expenditure level. Again, it is unclear why we would deem a person who chooses to buy fewer and more expensive calories as poorer than another person at the same real expenditure level.

In each of these cases, the real expenditure level at which an urban resident typically attains any given calorific requirement will tend to be higher than in
rural areas. And this can hold even if the cost of basic consumption needs is no different between urban and rural areas. The FEI method may thus build in differences between the poverty lines that are not related to the agreed-upon definition of the standard of living. In figure 1 the urban poverty line is \( z_u \) and the rural line is \( z_r \). However, there is nothing in the FEI method to guarantee that the differential \( z_u / z_r \) equals the differential in the cost of basic needs between urban and rural areas. An unwarranted differential in poverty lines may then appear, and the poverty profile will be inconsistent in terms of command over basic consumption needs.

In defense of the FEI method, it might be argued that higher poverty lines should be used in better-off areas to reflect the relative deprivation of the poor. For example, the difference in food tastes may be due to genuine feelings of relative deprivation in urban areas experienced by a poor person who does not conform to prevailing tastes in cities.

It is arguable whether feelings of relative deprivation should be included in an assessment of absolute poverty. If the objective of the policies (which are to be informed by the poverty profile) is to eliminate absolute poverty in terms of the attainment of basic consumption needs, then relative deprivation will have zero weight. But even if relative deprivation has a positive weight, it is unclear whether the FEI method uses the right value, because it is not known how important relative deprivation is to the poor. Thus it is worrying that the FEI method implicitly gives a positive value to relative deprivation. In short, we do not know in what sense the FEI method is consistent. A more transparent approach would identify the amount of extra money that would be needed to compensate the poor in rich areas for their relative deprivation and add this to the cost of basic needs.

These problems are quite worrying when there is mobility across the subgroups of the poverty profile, such as migration from rural to urban areas. Suppose the FEI poverty line has higher purchasing power in terms of basic needs in urban areas than in rural areas. Consider someone just above the FEI poverty line in the rural sector who moves to the urban sector and obtains a job there generating a real gain that is less than the difference in poverty lines across the two sectors. Although that person is better off—can buy more of all the basic needs, including food—the migrant will now be deemed poor in the urban sector, and the aggregate measure of poverty across the sectors will show an increase. Indeed, it is possible that a process of economic development through urban sector enlargement in which none of the poor is any worse off and at least some are better off would result in a measured increase in poverty. Similar points can be made concerning the use of the FEI method in making poverty comparisons over time; it is entirely possible that the method will show rising poverty rates over time even if all households have higher real incomes.

In summary, a priori considerations lead one to suspect that a poverty profile based on the FEI method could deviate from one that is consistent in terms of the household's command over basic needs. By anchoring poverty lines to the ob-
served empirical relation between food energy intake and total consumption expenditure within each subgroup, the FEI method can estimate poverty lines without data on prices. However, this particular anchor is going to shift across the poverty profile in ways that have little or nothing to do with differences in command over basic consumption needs. And it is not clear if there is any meaningful sense in which FEI poverty lines can be considered consistent in other nonbasic needs.

An Example from Indonesia

Indonesia’s Central Bureau of Statistics (Biro Pusat Statistik [BPS]) uses the FEI method to construct its poverty lines (BPS 1990, 1992). Its urban poverty line for 1990 of Rp20,614 is the estimated expenditure level at which a typical urban resident reaches the predetermined mean food energy requirement of 2,100 calories per person per day; the corresponding rural expenditure to reach the same caloric intake is Rp13,295. The Indonesian method is only one example of a common practice; we focus on this country in large part because the government expressed interest in the properties of this method and alternatives.

As is typically the case in developing countries, the urban relation between food energy intakes and total expenditures is different from the rural one, with higher intakes at given consumption expenditures in rural areas. This difference could well reflect one or more of the factors discussed above. The concern here is that these factors may lead to poverty lines that entail different standards of living in different subgroups of the poverty profile.

In principle, there are two equivalent ways to address this concern. First, it can be determined whether the typical consumption vectors at the FEI poverty lines imply the same standard of living. Second, the nominal poverty lines can be deflated by an appropriate cost-of-living index, normalizing for differences in the cost of a given standard of living. In practice, neither approach is straightforward. In this subsection we offer some casual observations; later we will present new evidence on spatial differences in the cost of living facing the poor.

What do people whose consumption expenditure is in the neighborhood of the BPS poverty lines typically consume? Using the data tapes of Indonesia’s National Socio-Economic Survey (SUSENAS) for 1990, we calculated the mean consumption vectors within a region Rp500 above and below the BPS poverty lines. The results are in table 1. Both the urban and rural bundles yield 2,100 calories per person per day. However, the rural bundle derives a higher share of its caloric value from the staple foodgrains. The urban bundle has higher consumptions of the “superior” food staple (rice), and lower consumptions of the “inferior” staples (corn and cassava). Similarly, the urban bundle has more

5. For an overview of the various approaches to poverty measurement used in the Indonesian literature, see World Bank (1990) and Booth (1992). Contributions to that literature have been made by Sayogyo and Wiradi (1985), Rao (1984), BPS (1989), and Asra (1989). Mention should also be made of the antecedents in the literature on poverty in India; see Bardhan (1970) and Dandekar and Rath (1971).
Table 1. **Average Consumption of Food Products in Food Bundles Used for FEI-Based Poverty Lines for Urban and Rural Areas in Indonesia, 1990**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>kg</td>
<td>9.626</td>
<td>8.078</td>
</tr>
<tr>
<td>Corn</td>
<td>kg</td>
<td>0.079</td>
<td>1.655</td>
</tr>
<tr>
<td>Cassava</td>
<td>kg</td>
<td>0.520</td>
<td>1.722</td>
</tr>
<tr>
<td>Fresh fish</td>
<td>kg</td>
<td>0.677</td>
<td>0.459</td>
</tr>
<tr>
<td>Dried fish</td>
<td>ons</td>
<td>1.646</td>
<td>1.792</td>
</tr>
<tr>
<td>Meat</td>
<td>kg</td>
<td>0.034</td>
<td>0.029</td>
</tr>
<tr>
<td>Chicken</td>
<td>kg</td>
<td>0.078</td>
<td>0.025</td>
</tr>
<tr>
<td>Chicken eggs</td>
<td>kg</td>
<td>0.195</td>
<td>0.054</td>
</tr>
<tr>
<td>Spinach/kangkung</td>
<td>kg</td>
<td>0.756</td>
<td>0.697</td>
</tr>
<tr>
<td>Tomato</td>
<td>ons</td>
<td>0.890</td>
<td>0.314</td>
</tr>
<tr>
<td>Cassava leaves</td>
<td>kg</td>
<td>0.209</td>
<td>0.630</td>
</tr>
<tr>
<td>Eggplant</td>
<td>kg</td>
<td>0.113</td>
<td>0.218</td>
</tr>
<tr>
<td>Vegetable soup</td>
<td>bks</td>
<td>0.350</td>
<td>0.075</td>
</tr>
<tr>
<td>Vegetable mix</td>
<td>bks</td>
<td>0.525</td>
<td>0.133</td>
</tr>
<tr>
<td>Onion</td>
<td>ons</td>
<td>1.199</td>
<td>1.001</td>
</tr>
<tr>
<td>Garlic</td>
<td>ons</td>
<td>0.184</td>
<td>0.137</td>
</tr>
<tr>
<td>Red pepper</td>
<td>ons</td>
<td>0.752</td>
<td>0.389</td>
</tr>
<tr>
<td>Cayenne pepper</td>
<td>ons</td>
<td>0.625</td>
<td>0.944</td>
</tr>
<tr>
<td>Tahu</td>
<td>kg</td>
<td>0.371</td>
<td>0.147</td>
</tr>
<tr>
<td>Tempe</td>
<td>kg</td>
<td>0.461</td>
<td>0.229</td>
</tr>
<tr>
<td>Rambutan</td>
<td>kg</td>
<td>0.343</td>
<td>0.132</td>
</tr>
<tr>
<td>Yellow bananas</td>
<td>kg</td>
<td>0.256</td>
<td>0.229</td>
</tr>
<tr>
<td>Other bananas</td>
<td>kg</td>
<td>0.353</td>
<td>0.668</td>
</tr>
<tr>
<td>Papaya</td>
<td>kg</td>
<td>0.179</td>
<td>0.123</td>
</tr>
<tr>
<td>Oil</td>
<td>liter</td>
<td>0.466</td>
<td>0.338</td>
</tr>
<tr>
<td>Coconut</td>
<td>number</td>
<td>0.843</td>
<td>1.271</td>
</tr>
<tr>
<td>White sugar</td>
<td>ons</td>
<td>5.157</td>
<td>3.665</td>
</tr>
<tr>
<td>Brown sugar</td>
<td>ons</td>
<td>0.974</td>
<td>0.866</td>
</tr>
<tr>
<td>Tea</td>
<td>ons</td>
<td>0.397</td>
<td>0.299</td>
</tr>
<tr>
<td>Coffee</td>
<td>ons</td>
<td>0.418</td>
<td>0.340</td>
</tr>
<tr>
<td>Salt</td>
<td>ons</td>
<td>1.550</td>
<td>1.937</td>
</tr>
<tr>
<td>Tamarind</td>
<td>ons</td>
<td>0.203</td>
<td>0.156</td>
</tr>
<tr>
<td>Fish paste</td>
<td>ons</td>
<td>0.339</td>
<td>0.284</td>
</tr>
<tr>
<td>Soya sauce</td>
<td>10 ml</td>
<td>1.786</td>
<td>0.342</td>
</tr>
<tr>
<td>Food and drink spending</td>
<td>Rp</td>
<td>1,160.55</td>
<td>302.32</td>
</tr>
</tbody>
</table>

**Note:** Consumptions per person per month for SUSENAS samples are within plus or minus Rp500 per person of the BPS poverty lines.

**Source:** Authors' calculations from 1990 SUSENAS data tapes. Units: ons = 100 gms, kg = 1 kilogram, bks = package.

expensive vegetables (tomatoes) with fewer cheaper ones (cassava leaves) than the rural bundle. The urban bundle also has higher consumptions of meat and chicken and considerably higher expenditures on food and drink consumed outside the home. Which of these two consumption bundles would one prefer, ignoring the difference in cost? Clearly one cannot answer this question in the abstract (there are theoretically admissible preferences that could go either way). But we would be surprised if most Indonesians did not choose the urban bundle.
The difference in the relation between food energy intake and total spending between urban and rural areas—and hence in the poverty lines—is so large that, at any given level of food energy requirement, the urban FEI poverty line exceeds the rural line by a magnitude sufficient to imply an estimated head-count index of poverty that is greater in the urban sector than the rural sector. This is illustrated in figure 2, which gives the estimated cumulative distribution of nominal consumption per person in urban and rural areas in Indonesia in 1990. At the BPS (1992) rural poverty line for 1990, about 14 percent of the rural population and 17 percent of the urban population is poor.

But at any given poverty line (fixed across both sectors) in figure 2, the proportion of the rural population deemed to be poor is higher than that of the urban population. And this holds wherever one draws that poverty line. If there is no difference in the cost of basic needs between urban and rural areas, then there is more poverty in rural areas no matter where the poverty line is drawn or what poverty measure is used (Atkinson 1987). However, there clearly are cost-of-living differences between urban and rural areas, and so this conclusion need not hold, given that the distributions in figure 2 are not adjusted for those differences. What is the critical poverty line differential needed to reverse the sectoral poverty ranking? It is easy to calculate that, as long as the urban poverty line is no more than 45 percent higher than the
rural poverty line, the head-count index will be higher in rural areas.\textsuperscript{6} The calculation gives the same result whether one uses the urban or rural BPS poverty line as the reference. But when using the BPS poverty lines, one obtains a differential of 55 percent, suggesting that the head-count index is higher in urban areas.

Unfortunately, no satisfactory spatial cost-of-living index is available for Indonesia. Markets may not be perfectly integrated spatially, but it is difficult to believe that existing transport costs and barriers to trade in Indonesia could yield a 45 percent differential in the prices of basic consumption items between urban and rural areas. Ravallion and van de Walle (1991) estimated a behavioral cost-of-living index for Java using a demand model estimated on 1981 SUSENAS data. The model allowed for housing cost differences (after controlling for observable differences in housing quality) and rice price differences. For the poor, the estimated cost-of-living difference between urban and rural areas was about 10 percent, although it was slightly greater than 20 percent between Jakarta and rural areas. Although clearly restricted in both commodity and geographical coverage, this result does not suggest that urban-rural cost-of-living differences are as high as the differential built into the BPS poverty lines or as high as the critical differential needed for the sectoral poverty ranking obtained by the BPS.

\section*{II. An Alternative Approach}

How robust is Indonesia's poverty profile to measurement assumptions? As a benchmark for comparison with the existing poverty profile based on the FEI method, we shall construct our own profile using a version of the CBN method. We do not claim our method to be ideal, but only that it is a credible alternative and can be implemented with the available data.

The first problem is setting the basic-needs bundle. Nutritional requirements are a defensible anchor for the food bundle, and when the composition of local food diets is also taken as given, the food component of a CBN poverty line is fully determined. Nonfood basic needs are a bigger problem, which we discuss further below.

The second problem is costing the basic-needs bundle. It is surprisingly rare for statistical agencies to provide spatial cost-of-living indexes analogous to the usual consumer price indexes (CPIS) used for intertemporal cost-of-living comparisons.\textsuperscript{7} For some time now, the lack of a suitable spatial price index for

\textsuperscript{6} This is calculated numerically by finding the differential in poverty lines that equates the head-count indexes in urban and rural areas.

\textsuperscript{7} CPIS are sometimes available by region. However, they are rarely valid for making spatial comparisons, because they are indexed to a common value in the base date for all regions.
Indonesia has clouded efforts to compare living standards across the archipelago (Booth 1992). The paucity of reliable price data—particularly for nonfood goods—severely constrains attempts to form a consistent regional poverty profile.

Our approach to estimating CBN poverty lines for Indonesia—to be compared with the existing FEI lines in the next section—incorporates two basic refinements to most past versions of the CBN method. First, we not only anchor the food component to the stipulated food energy requirement but we also adjust its composition to accord with observed diets of the poor. Second, we adopt a new method of setting nonfood basic needs consistent with the consumption behavior of those who can just afford their basic food needs.

However, because we are concerned with the way these methods rank subgroups in the poverty profile, we will calibrate the CBN method to yield an aggregate incidence of poverty similar to that yielded by the BPS using the FEI method. In particular, our CBN method will use the same specification of nutritional requirements. And we will choose the reference group for specifying tastes to accord with the estimates of poverty incidence obtained by the BPS. Our objective is not to come up with an alternative estimate of the extent of aggregate poverty incidence in Indonesia but rather to compare how these two methods rank subgroups, because this is what matters most to the policy implications.

The Food Poverty Line

First, we specify a reference household deemed to be typical of the poor. We choose that household to have the mean values of all relevant variables for the poorest 15 percent of the Indonesian population when ranked according to expenditure per capita. This is the same group of persons deemed to be poor in 1990 by the BPS (1992). The consumption pattern of this reference household becomes the anchor for the subsequent stages.

Next we set the poverty line in each region. A person is deemed poor who lives in a household that cannot afford the cost of a reference food bundle, chosen to yield adequate food energy intake, consistent with the typical diet of those deemed poor. Following past practice for Indonesia, we set the food energy requirement at 2,100 calories per person per day, again following the BPS (1990, 1992). The judgment about whether or not the household can afford the reference food bundle is based on the household’s consumption expenditure on all goods and services.

More formally, let \( x^r \) denote the actual food consumption vector of the reference group of households. The corresponding caloric values are represented by the vector \( k \), and the food energy intake of the reference household is then \( k^r = \)

8. As we have already noted, there is an inherent arbitrariness in setting food energy requirements, but this problem is common to both methods. We will test the robustness of the poverty measures based on the CBN method to the level of the poverty line.
The recommended food energy intake is $k^*$. The reference food consumption bundle used to construct the poverty line is then given by $x^*$ such that $k^* = kx^*$. There are, of course, infinitely many possible consumption vectors that would yield $k^*$. The particular composition of $x^*$ used to construct the poverty line is obtained by multiplying every element of $x^*$ by the constant $k^*/kx$'. Thus the relative quantities in the diet of the poor are preserved in setting the poverty line, and the absolute quantities are chosen to yield the stipulated food energy requirement.

Having selected the bundle of goods, we then value it at local prices in each region. In principle, this is straightforward, although in practice there are often problems of matching the price data with the budget data used to construct the reference food bundle. There is nothing of any general interest that can be said about those problems; we refer interested readers to Bidani and Ravallion (forthcoming), which describes the method in greater detail.

The Allowance for Nonfood Goods

In principle, one could proceed the same way for nonfood goods, that is, set a bundle of such goods and cost that bundle separately in each region and sector. However, certain considerations militate against that approach for nonfood goods. Although food energy requirements are the obvious anchor for food consumption, there is no analogous basis for setting basic nonfood consumption. Furthermore, as is common for most developing countries, nonfood prices are difficult to monitor reliably (indeed, prices for more than a few nonfood goods are rarely available from statistical agencies).

The problem is how one can best allow for differences in the basic nonfood goods needed to achieve the same standard of living in the various sectors or regions being compared. Past approaches to setting poverty lines have tried to anchor the allowance for nonfood goods to the consumption behavior of the poor but in ways that are likely to create biases in the poverty profile. For example, dividing by mean food share of the poorest 20 percent (say) in each subgroup will typically entail higher real poverty lines in richer regions. The idea of anchoring the allowance for nonfood goods to the consumption behavior of the poor does, however, make sense; the issue is more deciding on the appropriate point in the distribution of consumption among the poor. Here we implement the method suggested in Ravallion (1993: app. 1).

An appealing test for defining a basic nonfood need is that one is willing to forgo a basic food need in order to obtain that good. We can thus ask what level of nonfood spending people will allow to displace basic food spending as embodied in the food poverty line. There will undoubtedly be some displacement of basic food spending over a range of consumption levels. Even those households whose total consumption expenditure is below that required to meet their nutritional requirements with the traditional diet will almost certainly spend something on nonfood goods. The better measure of basic nonfood spending is to look at how much is spent on nonfood goods by households that are able to
reach their nutritional requirements but choose not to do so. Of course, quite large sums might be spent by some households on nonfood goods, even though nutritional requirements are not being adequately met. One may not want to identify all such households as poor. There will also be some variation in spending patterns at any given budget level, for example, variations resulting from measurement errors or random differences in tastes. Given this heterogeneity, a more reasonable approach is to ask what is the typical value of nonfood spending by a household that is just able to reach its food requirements. As long as nonfood is a normal good, this will also equal the lowest level of nonfood spending for households that are able to acquire the basic food bundle. It can thus be considered a minimal allowance for nonfood goods.

This definition of the basic nonfood component can be implemented quite easily with readily available data. To illustrate, let us assume that food spending increases with total spending, with a slope less than unity, and decreases as total spending increases (as implied by—but not implying—Engel’s law that the income elasticity of demand for food is less than unity). The relation between food spending and total spending is depicted in figure 3. It can be thought of as a regression line, giving the expected value of food spending at any given value of total spending. Let us also assume that there is a unique expenditure needed to reach nutritional requirements, as indicated in figure 3. This is the food poverty line, \( z_f \). Among households that can afford to reach their nutritional requirements (with given tastes), the lowest level of nonfood spending is given by the distance \( NF \) in figure 3, all of which displaces basic food spending. This, then, is the basic level of nonfood spending. The combined poverty line is given by \( z = (z_f + NF) \).

The value of \( NF \) can be estimated as follows. We begin with a demand function for food, representing the food share as a linear function of the log of total spending (food plus nonfood) in relation to the cost of basic food needs (augmented for other relevant variables; see the appendix for details on the derivation of the estimated model). For household \( i \) in region \( j \)

\[
(1) \quad s_{ij} = \alpha_f + \beta_f \log(y_{ij} / z_f) + \text{error term}_{ij}
\]

where \( s_{ij} \) is the share of total expenditure, \( y_{ij} \), devoted to food; \( z_f \) is the cost of basic food needs; and \( \alpha_f \) and \( \beta_f \) are parameters to be estimated. The value of the intercept \( \alpha_f \) estimates the average food share of those households that can just afford basic food needs, that is, those for whom \( y_{ij} = z_f \). (The squared value of \( \log(y_{ij} / z_f) \) will probably allow a better fit to the data, because it permits the income elasticity of demand for food to exceed unity at low values of \( y \).) The poverty line is given by

\[
(2) \quad z_f = z_f (2 - \alpha_f).
\]

In words, the poverty line is obtained by scaling up the food poverty line, the proportionate increase being given by the estimated nonfood budget share at the food poverty line.
Figure 3. Estimated Cost of Nonfood Basic Needs

This method does not insist that the nonpoor actually spend enough on food to buy the nutritionally adequate food bundle—that would entail a higher poverty line, where $z_f$ intersects with the food spending curve in figure 3—rather, it insists only that they are able to do so, as discussed in section I. Thus our method deems a person to have escaped poverty only if the person can afford the stipulated basic consumption needs; whether in fact the person also chooses to do so is another matter.

The Poverty Measures

Having estimated the regional poverty lines, the poverty measures are then estimated for each region and aggregated to the national level. Three standard poverty measures are used in this study.

- The head-count index is given by the percentage of the population living in households with a consumption per capita less than the poverty line. This measure has the advantage of being easy to interpret, but it tells us nothing about the depth or severity of poverty.

- The poverty gap index is defined by the mean distance below the poverty line expressed as a proportion of that line, where the mean is formed over the entire population, with the nonpoor counted as having a zero poverty gap. This is the Foster-Greer-Thorbecke (1984) definition of the poverty gap index. This definition has advantages over the income-gap ratio, obtained when the mean is formed only over the poor (see Ravallion 1993).

- The Foster-Greer-Thorbecke $P_2$ measure is defined as the mean of the squared proportionate poverty gaps. Again, the mean is formed over the
entire population, with the nonpoor counted as having a zero poverty gap. Unlike the poverty gap index, this measure reflects the severity of poverty in that it is sensitive to inequality among the poor.

III. Comparing Methods

We now compare the methods described in the previous two sections by using data for Indonesia. For the FEI method, we rely on the results reported in BPS (1992), based on the 1990 SUSENAS. The BPS poverty lines were constructed by the method described in section I, using graphs of mean food energy intake against consumption expenditure per person to locate the FEI-based poverty lines, with different graphs for each province of Indonesia and for urban and rural areas. For the CBN method, we follow the approach outlined in section II, using the same data set. For both methods, average food energy requirements are set at 2,100 calories per person per day.

In both cases, the data tapes of the 1990 SUSENAS were used to estimate the poverty measures for each region. The 1990 SUSENAS gives consumption data for a stratified sample of 45,000 households surveyed in January of that year. In all estimations, the inverse sampling rates estimated by the BPS were used to obtain unbiased population estimates. We shall summarize only the salient features here, before discussing the comparison; Bidani and Ravallion (forthcoming) documents the results in far greater detail.

Our reference food bundle for the CBN method includes 31 foods, allowing slightly more than 400 grams of foodgrains (plus cassava) per person per day, plus small amounts of fresh fish, meats, eggs, and a range of local vegetables, fruits, condiments, and spices. Of the 2,100 calories per person per day that this bundle yields, 81 percent comes from foodgrains and cassava. The average cost of the reference food bundle in January 1990 was Rp13,028; Rp14,043 in urban areas and Rp12,581 in rural areas. (Bidani and Ravallion [forthcoming] give the results by region.) Urban food prices were, on average, 12 percent higher than rural food prices. By contrast, the estimated cost of nonfood basic needs was 44 percent higher in urban areas. With the allowance for nonfood basic needs, the mean poverty line was Rp18,519 in urban areas and Rp15,693 in rural areas, giving an overall differential of 18 percent in the poverty lines across the two sectors.

Poverty Profiles by Each Method

Table 2 reports the aggregate poverty measures for Indonesia and for the urban and rural areas separately, using both the CBN and FEI methods. To help assess the sensitivity of the CBN method to the definition of basic needs, we also give some key results for the food component only. The national poverty measures by the FEI method lie between those we have estimated for the food poverty line and the total poverty line by the CBN method and are appreciably lower than the latter. However, the more dramatic difference—and of greater relevance to
Table 2. Alternative Poverty Measures for Indonesia, 1990

<table>
<thead>
<tr>
<th>Poverty measure</th>
<th>Area</th>
<th>CBN method</th>
<th>FEI method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Food only</td>
<td>Food plus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>nonfood</td>
<td>nonfood</td>
</tr>
<tr>
<td>Head-count index (percent)</td>
<td>Indonesia</td>
<td>7.93</td>
<td>19.63</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>2.80</td>
<td>10.67</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>10.20</td>
<td>23.58</td>
</tr>
<tr>
<td>Poverty gap index (percent)</td>
<td>Indonesia</td>
<td>0.97</td>
<td>3.46</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>0.31</td>
<td>1.67</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>1.26</td>
<td>4.25</td>
</tr>
<tr>
<td>Foster-Greer-Thorbecke $P_2$ index (x100)</td>
<td>Indonesia</td>
<td>0.18</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>0.06</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td>0.24</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Source: For estimates based on the CBN method, authors' calculations from BPS price data and 1990 SUSENAS data tapes; for estimates based on the FEI method, BPS (1992).

Policy—-is that the FEI method shows urban poverty to be higher than rural poverty, a result driven by the far larger (55 percent) urban-rural differential in the poverty lines generated by the FEI method. The difference is sufficient to reverse the sectoral rankings for all three poverty measures.

Poverty incidence curves, plotting the percentage of the population consuming less than a given proportion of the poverty line, are shown in figure 4 for both urban and rural areas, using both the FEI and CBN methods. The results show that the CBN poverty incidence curve for urban areas lies everywhere below that for rural areas, implying that the percentage of the population deemed poor for any given poverty line in rural areas is unequivocally higher than for urban areas. Indeed, whatever the poverty line or poverty measure, there is higher poverty in rural areas than urban areas. (This follows from the application of stochastic dominance theory to poverty comparisons; see Atkinson 1987.) By contrast, the poverty lines based on the FEI method imply intersecting poverty incidence curves, although the intersection point is high; up to about 150 percent of the poverty line, the FEI method gives higher poverty in urban areas.

We present more detailed results using both methods for the head-count index by region in table 3. Using the CBN poverty lines, the incidence of poverty is markedly higher in rural areas than in urban areas. The most striking result from table 3 is the extent of reranking that occurs when one switches from the

9. The poverty deficit curves (given by the areas under the poverty incidence curves) show higher poverty in urban areas up to three times the urban poverty line (not presented, but available from the authors). Thus all poverty measures that are strictly decreasing in consumptions of the poor will show higher poverty in urban areas (Atkinson 1987).

10. Results for alternative poverty lines and poverty measures using the CBN method are available in Bidani and Ravallion (1993). The regional and urban-rural rankings in terms of poverty are not very sensitive to these choices. The BPS (1992) omits results for some regions, although they are included in the aggregates reported in table 2.
Table 3. Poverty Profile by Region Using Alternative Methods, 1990
(percentage of subgroup’s population deemed to be poor)

<table>
<thead>
<tr>
<th>Province</th>
<th>Urban plus rural</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CBN method</td>
<td>FEI</td>
<td>CBN method</td>
</tr>
<tr>
<td>Aceh</td>
<td>11.49</td>
<td>15.91</td>
<td>6.74</td>
</tr>
<tr>
<td>North Sumatra</td>
<td>12.05</td>
<td>13.53</td>
<td>8.18</td>
</tr>
<tr>
<td>West Sumatra</td>
<td>13.35</td>
<td>15.01</td>
<td>0.92</td>
</tr>
<tr>
<td>Riau</td>
<td>13.07</td>
<td>13.66</td>
<td>4.89</td>
</tr>
<tr>
<td>Jambi</td>
<td>11.23</td>
<td>n.a.</td>
<td>5.20</td>
</tr>
<tr>
<td>South Sumatra</td>
<td>14.63</td>
<td>16.81</td>
<td>4.27</td>
</tr>
<tr>
<td>Bengkulu</td>
<td>24.56</td>
<td>n.a.</td>
<td>9.60</td>
</tr>
<tr>
<td>Lampung</td>
<td>28.17</td>
<td>13.12</td>
<td>15.74</td>
</tr>
<tr>
<td>Jakarta</td>
<td>1.30</td>
<td>7.79</td>
<td>1.30</td>
</tr>
<tr>
<td>West Java</td>
<td>17.61</td>
<td>13.89</td>
<td>16.21</td>
</tr>
<tr>
<td>Central Java</td>
<td>24.69</td>
<td>17.49</td>
<td>11.13</td>
</tr>
<tr>
<td>Yogyakarta</td>
<td>17.22</td>
<td>15.50</td>
<td>10.68</td>
</tr>
<tr>
<td>East Java</td>
<td>21.80</td>
<td>14.78</td>
<td>15.28</td>
</tr>
<tr>
<td>Bali</td>
<td>12.19</td>
<td>11.21</td>
<td>9.68</td>
</tr>
<tr>
<td>West Nusa Tenggara</td>
<td>27.61</td>
<td>23.18</td>
<td>21.36</td>
</tr>
<tr>
<td>East Nusa Tenggara</td>
<td>45.62</td>
<td>24.06</td>
<td>17.95</td>
</tr>
<tr>
<td>West Kalimantan</td>
<td>33.83</td>
<td>27.58</td>
<td>14.69</td>
</tr>
<tr>
<td>Central Kalimantan</td>
<td>18.65</td>
<td>n.a.</td>
<td>12.34</td>
</tr>
<tr>
<td>South Kalimantan</td>
<td>8.69</td>
<td>21.17</td>
<td>0.87</td>
</tr>
<tr>
<td>East Kalimantan</td>
<td>14.00</td>
<td>n.a.</td>
<td>4.85</td>
</tr>
<tr>
<td>North Sulawesi</td>
<td>18.79</td>
<td>14.88</td>
<td>5.16</td>
</tr>
<tr>
<td>Central Sulawesi</td>
<td>24.91</td>
<td>n.a.</td>
<td>2.18</td>
</tr>
<tr>
<td>South Sulawesi</td>
<td>23.12</td>
<td>10.79</td>
<td>5.22</td>
</tr>
<tr>
<td>Southeast Sulawesi</td>
<td>28.84</td>
<td>n.a.</td>
<td>16.34</td>
</tr>
<tr>
<td>Maluku</td>
<td>29.04</td>
<td>n.a.</td>
<td>7.34</td>
</tr>
<tr>
<td>Irian Jaya</td>
<td>12.61</td>
<td>n.a.</td>
<td>12.61</td>
</tr>
<tr>
<td>Aggregate</td>
<td>19.63</td>
<td>15.08</td>
<td>10.67</td>
</tr>
</tbody>
</table>

n.a. Not available.

Source: For estimates based on the FEI method, BPS (1992); for estimates based on the CBN method, authors’ calculations from BPS price data and 1990 SUSENAS data tapes.

CBN to the FEI method. This can be seen in figure 5, which ranks all regions (provinces are split between urban and rural areas) by the head-count index for the FEI poverty lines and which plots the corresponding CBN estimate of that index. If the two methods agree in their ranking, then one would observe a monotonic increasing (although not necessarily straight) line joining all the points. Instead, there are numerous rerankings. For example, if one asks what the 10 poorest regions are, one will find only three regions in common between the two methods. The overall rank correlation coefficient is 0.15 \((n = 35)\), which is not significantly different from zero. The two methods are virtually rank-orthogonal.

Figure 5 distinguishes the urban and rural points. As in table 2, the CBN method generally gives higher poverty measures in rural areas, and reranking is evident across provinces within each of the urban and rural sectors, as well as
Figure 4. Poverty Incidence Curves Using the CBN and FEI Methods for Rural and Urban Areas in Indonesia, 1990

Cumulative percentage of persons

Note: Poverty incidence curves plot the percentage of the population consuming less than a given proportion of the poverty line.
Source: SUSENAS data tapes.

Figure 5. The Head-Count Index Using the CBN and FEI Methods for Rural and Urban Areas in the Provinces of Indonesia, 1990

Head-count index using the CBN method

Note: The lines are constructed by starting with the FEI method values in table 3 ranked in ascending order and plotting them against the CBN values. Thus, the first value for the urban comparison is for Jakarta: 7.79 percent using the FEI method and 1.30 percent using the CBN method.
between them; comparing urban areas only, the rank correlation is 0.51 \((n = 18)\); for rural areas it is 0.17 \((n = 17)\).

The FEI method better approximates the provincial-level poverty profile (combining urban and rural areas) based on the CBN poverty lines (figure 6). Among (say) the poorest five provinces, by each method there are now four in common (East and West Nusa Tenggara, West Kalimantan, and Central Java). However, a considerable amount of reranking occurs among other provinces, and the overall rank correlation coefficient is 0.39 \((n = 18)\), which is (just barely) significantly different from zero at the 5 percent level.

So far we have focused on a single basic-needs bundle and a single poverty measure. How sensitive are poverty rankings to that choice? In figure 7 we compare results for the food-plus-nonfood basic needs bundle with those for food alone. We also compare the Foster-Greer-Thorbecke \(P_2\) index with the head-count index (both using the CBN poverty line). In both comparisons, there is some reranking, but certainly far less than in comparing the CBN method with the FEI method. The rank correlation coefficient between the two poverty lines (food, and food plus nonfood) is 0.94 (0.86 for urban areas, 0.93 for rural areas), and that between the head-count index and the Foster-Greer-Thorbecke \(P_2\) index is 0.95 (0.93 urban, 0.87 rural). Bidani and Ravallion (forthcoming) give results for other combinations of poverty measures and poverty lines; the results are similarly robust.

\textbf{Figure 6. The Head-Count Index Using the CBN and FEI Methods for the Provinces of Indonesia, 1990}

The lines are constructed by starting with the FEI method values in table 3 ranked in ascending order and plotting them against the CBN values. Thus, the first value in the comparison is for Jakarta: 7.79 percent using the FEI method and 1.30 percent using the CBN method.
Within the CBN method, it is also of interest to see how rankings are affected by adjusting for spatial differences in the cost of the basic-needs bundle (a similar question is posed by Thomas [1980] for Peru). Separating urban and rural areas, the rank correlation between the head-count index using local poverty lines and that using the national mean poverty line (in effect, using national mean prices) was 0.88; at the provincial level it was 0.77. Again, although there is some reranking, this choice appears to matter far less than the choice between the CBN and FEI methods.

We also examined Indonesia's poverty profile by the primary sector of employment. Previous studies (Huppi and Ravallion 1991) on this subject have lacked access to a suitable regional price index. Table 4 compares the sectoral profiles obtained by using poverty lines derived by the CBN and FEI methods. Figure 8 ranks all the sectors (split by urban and rural) by the head-count index of the FEI method and plots the corresponding head-count estimates using the CBN method. The figure shows that the estimates of the urban head-count index derived using the FEI method are higher than those using the CBN method, although the rankings are very similar. Only in two cases are there rerankings. The estimates of the head-count index for rural areas using the FEI method are much lower than those obtained using the CBN method. However, in contrast to urban areas, there is substantial reranking in rural areas, especially among the sectors that have head-count indexes between 5 and 10 percent according to the FEI method. These sectors include laborers employed in the industrial sector, and both laborers and self-employed in the transport sector. Overall, across urban
Table 4. Poverty Profile by Sector of Employment Using Alternative Methods, 1990

<table>
<thead>
<tr>
<th>Principal sector of employment</th>
<th>Type of worker</th>
<th>Urban CBN method</th>
<th>Urban FEI method</th>
<th>Rural CBN method</th>
<th>Rural FEI method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming*a</td>
<td>Laborer</td>
<td>21.53</td>
<td>35.23</td>
<td>32.37</td>
<td>19.24</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>20.33</td>
<td>33.33</td>
<td>26.29</td>
<td>15.79</td>
</tr>
<tr>
<td>Mining*b</td>
<td>Laborer</td>
<td>8.68</td>
<td>16.86</td>
<td>9.79</td>
<td>4.95</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>n.a.</td>
<td>n.a.</td>
<td>25.35</td>
<td>8.86</td>
</tr>
<tr>
<td>Industry*c</td>
<td>Laborer</td>
<td>10.24</td>
<td>20.29</td>
<td>14.97</td>
<td>5.82</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>13.78</td>
<td>25.78</td>
<td>25.33</td>
<td>14.08</td>
</tr>
<tr>
<td>Construction</td>
<td>Laborer</td>
<td>15.02</td>
<td>31.06</td>
<td>17.21</td>
<td>8.70</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>12.05</td>
<td>20.50</td>
<td>13.95</td>
<td>7.60</td>
</tr>
<tr>
<td>Trade*d</td>
<td>Laborer</td>
<td>6.93</td>
<td>13.09</td>
<td>16.66</td>
<td>8.04</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>9.50</td>
<td>19.26</td>
<td>14.76</td>
<td>7.00</td>
</tr>
<tr>
<td>Transport*e</td>
<td>Laborer</td>
<td>6.25</td>
<td>14.63</td>
<td>12.02</td>
<td>6.23</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>19.03</td>
<td>32.19</td>
<td>14.02</td>
<td>6.22</td>
</tr>
<tr>
<td>Finance*f</td>
<td>Laborer</td>
<td>1.19</td>
<td>3.02</td>
<td>7.58</td>
<td>8.91</td>
</tr>
<tr>
<td>Services*</td>
<td>Laborer</td>
<td>3.95</td>
<td>9.89</td>
<td>6.59</td>
<td>3.65</td>
</tr>
<tr>
<td></td>
<td>Self-employed</td>
<td>12.96</td>
<td>20.53</td>
<td>16.82</td>
<td>7.86</td>
</tr>
<tr>
<td>Other</td>
<td>Laborer</td>
<td>9.00</td>
<td>19.54</td>
<td>20.90</td>
<td>13.92</td>
</tr>
<tr>
<td>Transfers*</td>
<td>n.a.</td>
<td>4.74</td>
<td>10.23</td>
<td>11.99</td>
<td>6.49</td>
</tr>
</tbody>
</table>

Note: Sectors with small sample sizes have been omitted from the analysis. These are self-employed urban mining, self-employed finance (both urban and rural), self-employed others (both urban and rural), and the entire sector of electricity, water, and gas.

n.a. Not applicable.
a. Farming, husbandry, forestry, hunting, and fishing.
b. Mining and excavating.
c. Industrial processing.
d. Wholesale, retail, restaurant, and hotel.
e. Transport, warehousing, and communication.
f. Finance, insurance, building rental, real estate, and office services.
g. Community services, social services, and personal services.
h. Pensions, gifts, and support from relatives.

Source: Authors' calculations from 1990 SUSENAS data tapes.

and rural sectors, the rank correlation coefficient between the poverty measures using the CBN method and the FEI method is 0.28 (n = 33); comparing urban sectors only it is 0.99 (n = 16); and among rural sectors alone it is 0.76 (n = 17).

Why Do the FEI and CBN Methods Differ So Much?

Even purely random differences between two sets of poverty lines could produce reranking of regions and sectors. However, the discrepancies between the FEI and CBN poverty lines are not random; they are correlated with another key variable determining the poverty profile.

Across regions, both the FEI and CBN poverty lines vary positively with mean consumption, but the FEI lines have a considerably higher elasticity to the mean, thus dampening the response of FEI-based poverty measures to differences in absolute levels of living. Across all regions (pooling urban and rural areas), the least squares elasticity of the FEI poverty line with respect to mean consumption
Figure 8. The Head-Count Index Using the CBN and the FEI Methods for Rural and Urban Areas by Major Sectors of Employment in Indonesia, 1990

Head-count index using the CBN method

Note: The lines are constructed by starting with the FEI method values in table 4 ranked in ascending order and plotting them against the CBN values. Thus, the first value in the comparison for rural areas is for laborers in the service sector: 3.65 percent using the FEI method and 6.59 percent using the CBN method.

is 0.86 (with a t-ratio of 15); by contrast, the analogous elasticity of the CBN poverty line is 0.31 (t = 6.7). This pattern persists within each of the urban and rural sectors separately.11 The basic-needs purchasing power of the FEI line (deflated by the CBN line) has an elasticity of 0.77 (t = 10) with respect to the basic-needs purchasing power of the mean. Households in better-off regions are typically reaching the stipulated food energy requirements at higher levels of living. This could be due to any one of the factors described in section I.

The elasticity of the FEI lines to the mean is far higher than one finds in the cross-country relation between the poverty line and average living standards among developing countries and is actually more typical of industrial countries; the elasticity of the CBN line is more similar to the elasticity one finds among low- and middle-income countries (Ravallion, Datt, and van de Walle 1991).

In short, the measures based on the FEI method behave more like relative poverty measures that depend mainly on the differences in Lorenz curves between subgroups in the poverty profile. This appears to be an important factor accounting for the extent of reranking. Clearly, if one is aiming to guide policy choices for reducing absolute poverty, the relative insensitivity of the FEI-based measures to differences in absolute levels of living is of concern.

11. Across urban areas only, the least squares elasticity of the FEI line to the mean is 0.64 (t = 4.72), whereas for the CBN line it is 0.41 (3.52). For rural areas, the corresponding figures are 1.04 (5.98) and 0.40 (2.71).
IV. Conclusions

Poverty comparisons, such as where or when poverty is greatest, often matter far more to policy choices than do aggregate poverty measures, such as how many people are deemed poor. Thus we should look very closely at how measurement practice affects the empirical profile of poverty. In this article we have discussed the pros and cons of alternative approaches to constructing a poverty profile and have implemented alternative methods on the same data set.

As in many countries, past methods of constructing poverty profiles in Indonesia have used the FEI method, whereby one defines the poverty line as the nominal consumption expenditure at which a person typically attains a predetermined food energy intake in each subgroup. We argue that this method can yield differentials in poverty lines (such as between urban and rural areas) in excess of the cost-of-living differential facing the poor. Thus the method can mislead policy choices aimed at reducing absolute poverty. For comparison, we have outlined an alternative—the CBN method, in which an explicit bundle of foods typically consumed by the poor is valued at local prices, with a minimal allowance for nonfood goods consistent with spending by the poor. Although not ideal, this is a conceptually transparent and operational alternative that can be implemented with the available data. We argue that this approach is more likely to generate a consistent poverty profile in that two persons with the same measured standard of living—measured by purchasing power over basic consumption needs—will be treated the same way. Our approach is a refinement of past approaches, retaining some seemingly desirable features (such as the concern to respect the tastes of the poor) while trying to avoid others (such as the implicit use of a higher real poverty line in richer regions of the same country).

Comparing these two methods for Indonesia, the CBN method finds greater poverty incidence, depth, and severity in rural areas, while the reverse is indicated by the FEI method. The ranking of regions (each province divided into urban and rural areas) by the two methods has virtually zero correlation. The poverty profile by principal sector of employment is less sensitive to the choice of method (particularly in urban areas). Nonetheless, this case study and our supportive a priori arguments lead us to conclude that policymakers should be wary of how the underlying poverty measures have been constructed before using the derived poverty profiles to formulate poverty-reduction policies.

On a positive note, we have found that our alternative poverty profile, based on the CBN method, is fairly robust to a number of other methodological choices, notably changes in the composition of the basic needs bundle (determining the overall level of the poverty line), differences in the functional form of the poverty measure, and adjustment for spatial differences in prices. Ironically, although these issues have tended to dominate debates on how to measure poverty, our results suggest that they matter less to poverty rankings, and (hence) policy conclusions, than do the choices made in mapping a given specification of basic needs into monetary poverty lines.
Appendix. Derivation of the Nonfood Component of the CBN

An estimate of the food Engel curve is needed to make the allowance for nonfood consumption using our CBN method (section II). We postulated that the food share of household expenditure was a function of the food purchasing power of per capita consumption expenditure and the structure of relative (food-nonfood) prices. To derive this model, consider the following version of the Almost Ideal Demand System (Deaton and Muellbauer 1980):

\[ s_i = \alpha f + \beta f \ln \left( \frac{y_i}{c_i^f} \right) + \gamma f f \ln z_i^f + \gamma f n \ln p_i^n + \mu_i \]

where \( s_i \) is the food share of household expenditure for household \( i \), \( y_i \) is the per capita consumption expenditure of \( i \), \( c_i^f \) is the cost of zero utility, \( z_i^f \) is our estimate of the cost of the reference food bundle (that is, the food poverty line), and \( p_i^n \) is the price of a composite bundle of nonfood goods. The cost of zero utility is given by

\[ \ln c_i^f = \alpha_0 + \alpha f \ln z_i^f + \alpha^n \ln p_i^n \]

\[ + \frac{1}{2} \left[ \gamma f f (\ln z_i^f)^2 + 2 \gamma f n \ln z_i^f \ln p_i^n + \gamma n n (\ln p_i^n)^2 \right] + x_i \pi \]

where \( x_i \) represents a vector of other exogenous variables (for example, demographic variables). Under the parameter restrictions implied by the fact that the budget shares must sum to unity (\( \alpha f + \alpha^n = 1 \)), the demands must be homogeneous of degree zero in prices (\( \gamma f f + \gamma f n = 0 \), \( \gamma f n + \gamma n n = 0 \)) and the Slutsky matrix must be symmetric (\( \gamma f n = \gamma n f \)), equation A-1 can also be written in the form

\[ s_i = \alpha f + \beta f \ln \left( \frac{y_i}{z_i^f} \right) + \delta_i \ln k_i + \mu_i \]

where

\[ \ln k_i = \ln \left( \frac{p_i^n}{z_i^f} \right) \]

\[ \delta_i = \gamma f f - \beta f \left( 1 - \alpha f + \gamma f f k_i / 2 \right). \]

Because nonfood prices are unavailable, we introduce dummy variables for provinces and urban and rural areas to capture differences in relative prices, in the level of public services, and in other differences across regions that we do not observe. By adding an additional random error term we obtain the following specification:

\[ s_i = \alpha + \beta_0 \ln \left( \frac{y_i}{z_i^f} \right) + \sum_{j=1}^{n} \phi_j D_{ij} + x_i \pi + \nu_i. \]

We tested this against some ad hoc alternatives. One was to include the log of food price as a separate regressor; the coefficient on this variable was insignificant. However, we found that a significant improvement in fit could be obtained by adding a term in the squared value of \( \ln \left( \frac{y_i}{p_i^n} \right) \). The vector of demographic
variables includes the age-sex composition of the household in the following age groups: under 5, 5 to 9, 10 to 14, 15 to 59, and over 59; dummy variables for the education, marital status, and sex of the household head; and the number of individuals employed in the household. We then obtained the following estimate of this specification of the Engel curve on the 45,000 households in the SUSENAS sample. (Absolute t-ratios are in parentheses. This is a weighted least squares estimate, assuming that the error variance is proportional to the inverse sampling rate for each household. This improved the overall fit slightly.)

\[(A-7) \quad s = 0.67 - 0.061 \log(y/\bar{z}) - 0.028 [\log(y/\bar{z})]^2 \]
\[(127.5) (28.3) (26.2)\]

+ Demographic variables + Province urban/rural dummy variables \[R^2 = 0.489.\]

We use this equation to compute the poverty line, \(z\), for the reference household in each region. Hence, \(z_j = \bar{z}(2 - \alpha_j )\) where \(\alpha_j = \tilde{\alpha} + \tilde{x}_{(15)} + \tilde{\phi} + \tilde{\phi}_{(15)}\) give the characteristics of the reference household, that is, the mean of the demographic variables of the poorest 15 percent nationally.

We estimated the food Engel curve nationally and introduced a dummy variable for each region, thereby restricting the effects of the other explanatory variables in the regression to be the same across all the regions. This is more restrictive than estimating a separate regression for each region, although it is more computationally convenient, given the large number of regions in our study. To help assess the impact of this restriction on the results, we estimated separate food Engel curves for a subset of 20 regions. There were very few rerankings in the estimated head-count indexes (the overall rank correlation coefficient was 0.99). We also tested sensitivity to the use of a weighted regression (rather than unweighted) and to minor changes in the explanatory variables; poverty rankings were similarly robust to these changes.

REFERENCES

The word "processed" describes informally reproduced works that may not be commonly available through library systems.


The Impact of Two-Tier Producer and Consumer Food Pricing in India

Maurice Schiff

India's government buys wheat, rice, and sugar at below the market price and then sells it in ration shops in the urban and rural areas. The rest is sold in the open market. This creates a two-tier price system for consumers and producers. Supporters of the government's procurement policy claim that it raises the open-market price so much that it increases the sales-weighted average of the rationed price and the open-market price; in that case, both the farm sector as a whole and low-income urban consumers with access to the ration shops gain, and high-income urban consumers who buy at the open-market price lose. This view has provided an intellectual basis for the policy.

This article examines a variety of cases: with and without rationing; with rationing through ration cards or queuing; with and without access by the urban rich to the ration shops; with or without free trade; and with a marketable surplus having either positive, negative, or zero price elasticity. The impact of the policy on the average price is in general ambiguous or negative. Under the most plausible assumptions, it is negative, implying that farmers as a whole lose from the procurement policy.

Governments in developing countries generally discriminate against agriculture.1 Export crops are taxed to transfer resources to the rest of the economy, and food crops are often taxed to provide cheaper food to urban consumers.2 To attain the latter objective, several countries have instituted a procurement policy: the government buys food commodities from producers at below-market prices and then sells them to low-income consumers through ration shops. The governments thus impose a producer levy on the output they buy. Producers may supply additional demand at any price the market will bear. This policy results in a two-tier price system for producers and consumers. In the Punjab, India,

2. However, Schiff and Valdés (1992) report that when food is imported, most developing countries tax the imports and protect the producers. In those cases, the cheap-food motive is dominated by the self-sufficiency and revenue motives.

Maurice Schiff is in the Policy Research Department of the World Bank. The author would like to thank participants at a World Bank seminar sponsored by the Agriculture Division, India Department; at the Agricultural Policy Workshop organized by the World Bank and the Indira Gandhi Institute for Development (New Delhi, January 1993); and at a seminar at the University of Namur (Belgium, August 1993); as well as three anonymous referees, for useful comments.

© 1994 The International Bank for Reconstruction and Development / THE WORLD BANK
wheat procurement has averaged about 50 percent of output and rice between
60 and 80 percent of output since the late 1960s.

India’s food procurement policy applies essentially to wheat, rice, and sugar.
Procurement is carried out at the local market for wheat and at the mill for rice
and sugar. For wheat, the government has closed surplus states following
droughts to depress the procurement price. Imports were increased in times of
drought in the 1970s, less so in the 1980s when large stocks had been accumu-
lated (Subbarao 1992; Gulati 1987).

Wheat farmers in India’s surplus states have recently refused to sell their
output to the government procurement agencies. The boycott was intensified
after a call by the India Farmers Union to boycott the procurement agencies as a
protest against low procurement prices and severe restrictions on selling wheat
to other states (The Times of India, May 8, 1992; The Economic Times, May 7,
1992). But Dantwala (1967, 1986); Mellor (1968); and Hayami, Subbarao, and
Otsuka (1982) have argued that farmers do not suffer from the procurement
policy. They claim that since procurement increases the open-market price, the
average of the procurement price and the open-market price is no less than the
price farmers would have obtained without procurement. In fact, Hayami, Sub-
barao, and Otsuka formally model markets with government procurement and
conclude that a procurement policy leads to an increase in the average price
received by farmers both in the short and the long run. That conclusion contra-
dicts the behavior of wheat farmers, who resisted selling their output to the
procurement agencies.

Assuming that production occurs in a competitive industry, farmers cannot on
their own achieve price discrimination between various consumer groups to
increase profits. The question is whether the public procurement and distribu-
tion policy can result in a price discrimination scheme that actually raises farm
profits. Dantwala (1967); Mellor (1968); and Hayami, Subbarao, and Otsuka
(1982) argue that farm profits unambiguously increase. I argue that farm profits
increase only under somewhat questionable assumptions (no rationing and no
access by the rich to the ration shops) coupled with restrictive conditions (that
the policy only be applied infinitesimally). Under reasonable assumptions pro-
ducers will suffer from the policy.

This issue is examined in Schiff (forthcoming) for two cases involving ration-
ing, a positive price elasticity of marketable surplus, a closed economy, and,
alternatively, with or without market segmentation between rich and poor. This
article examines the issue under more general conditions. For instance, trade
liberalization in agricultural products is presently being discussed by the govern-
ment of India (and has been carried out to a large extent in several other

3. There are several limitations to Hayami, Subbarao, and Otsuka’s (1982) analysis. For instance, they
describe the policy as entailing queues by the urban poor to obtain the rations at the fair-price shops, but
their model includes no cost of waiting and assumes no rationing. They also state that the access to the
ration shops is general, but their model assumes market segmentation with the access restricted to the
poor (pp. 655–56).
developing countries). Hence, the free trade case is examined here. The procurement and distribution policy is analyzed under the following conditions: with and without market segmentation between urban rich and poor; with and without rationing; with rationing through ration cards and through queuing; under free trade and for a closed economy; for a positive, zero, or negative price elasticity of marketable surplus; and for the short run and long run. These conditions were not all considered in previous analyses. The results are summarized in table 1.4

The remainder of the article is organized as follows. Section I presents the model and discusses a number of issues in preparation for the analysis in section II of the cases of free trade, closed economy with no rationing, closed economy with rationing and market segmentation, and closed economy with rationing and no market segmentation. Section III concludes.

I. THE MODEL

The analysis is carried out in a partial equilibrium framework. For simplicity, the model abstracts from administrative costs and marketing margins. This simplification does not affect the results as long as these costs are the same for the private and public sectors. This assumption biases the results in favor of those obtained by Hayami, Subbarao, and Otsuka (1982), since public sector costs are likely to be larger than private sector costs. The implication of differential costs is discussed in the concluding section.

If the authorities use public funds to subsidize the operation, the average farm price will be larger than the average consumer price. Farmers as a whole and consumers will benefit more from the policy than they would if there were no subsidies. This article assumes that the procurement and distribution policy is self-financed. In other words, no budgetary resources are used to provide explicit subsidies. This enables the results to be compared with those of others (for example, Hayami, Subbarao, and Otsuka 1982).

Farmers typically produce more than one product. It is precisely because of the existing substitution possibilities with other farm products that the supply curve in equation 1 has a positive slope. Assuming that there are no distortions in the other product markets, the analysis focuses exclusively on the impact of procurement and distribution policies on the product in question. That also enables comparison of the results with those of others.

The model assumes that there are three sets of demands, $D_U^p$ of the urban rich, $D_p^p$ of the urban poor, and $D_F$ of residents in rural areas. It also assumes that output depends on current price and abstracts from dynamic considerations that result from production lags or storage.

---

4. The case where the procurement price is higher than the market price and acts as a price floor (which has happened in some bumper crop years) is not considered. Also, the analysis abstracts from the impact of the policy on price variability. Hayami, Subbarao, and Otsuka (1982) find that procurement policy increases the likelihood of unstable market prices.
Table 1. The Impact of a Procurement Policy on the Open-Market Price and the Average Price of a Commodity

<table>
<thead>
<tr>
<th>Market characteristic</th>
<th>No trade (price elasticity of marketable surplus)</th>
<th>Zero</th>
<th>Negative</th>
<th>Free trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>No rationing; segmented market between rich and poor</td>
<td>$P_m$ and $\bar{P}$ may rise or fall unless $P_m = P_0$, in which case $dP_m/dP_0 &lt; 0$ and $d\bar{P}/dP_0 &lt; 0$.</td>
<td>$P_m$ increases; $\bar{P}$ may rise or fall unless $P_m = P_0$, in which case $d\bar{P}/dP_0 &lt; 0$.</td>
<td>$P_m$ and $\bar{P}$ may rise or fall.</td>
<td>$P_m$ unchanged; $\bar{P}$ falls.</td>
</tr>
<tr>
<td>Rationing; segmented market between rich and poor</td>
<td>No queuing</td>
<td>$P_m$ and $\bar{P}$ may rise or fall.</td>
<td>$P_m$ increases; $\bar{P}$ may rise or fall.</td>
<td>$P_m$ and $\bar{P}$ may rise or fall.</td>
</tr>
<tr>
<td></td>
<td>Queuing</td>
<td>$P_m$ rises; $\bar{P}$ falls.</td>
<td>$P_m$ unchanged; $\bar{P}$ falls.</td>
<td>$P_m$ may rise or fall; $\bar{P}$ falls.</td>
</tr>
<tr>
<td>Rationing; unsegmented market</td>
<td>No queuing</td>
<td>$P_m$ increases; $\bar{P}$ falls.</td>
<td>$P_m$ increases; $\bar{P}$ falls.</td>
<td>$P_m$ and $\bar{P}$ may rise or fall.</td>
</tr>
<tr>
<td></td>
<td>Queuing</td>
<td>$P_m$ rises; $\bar{P}$ falls.</td>
<td>$P_m$ unchanged; $\bar{P}$ falls.</td>
<td>$P_m$ may rise or fall; $\bar{P}$ falls.</td>
</tr>
</tbody>
</table>

Note: The procurement policy sets the procurement price below the open-market price. In the table, $P_0$ denotes the procurement price, $P_m$ the open-market price, and $\bar{P}$ the average price.

a. The results of the case of no trade also hold if trade is controlled by the government and is independent of price.

b. If the market is segmented between rich and poor, the rich have no access to the rationed units at price $P_m$, but the poor do have access to the units sold in the open market at price $P_m$. There can be no case of no rationing and an unsegmented market because in that case all consumers buy at $P_0$, resulting in excess demand that must be rationed (unless $dM/d\bar{P}$ is so negative that farmers exactly release the increase in urban demand, but that raises problems of multiple equilibria and stability).

c. This holds only for a "small" reduction in $P_0$ and if $|E^P| > |E^R|$, where $E^j$ is the price elasticity of demand of group $j = P$ [poor], $R$ [rich]. Available evidence on India indicates that $|E^P| > |E^R|$. 

d. This holds if $E^U \leq 1 + \frac{Y}{(P_m - P_0)Q_0}$, where $E^U$ is the income elasticity of demand of urban consumers, $Y$ is urban income, and $(P_m - P_0)Q_0$ is the value of the property rights to the rationed units, $Q_0$. Evidence indicates that this condition is easily satisfied.

e. $\bar{P}$ falls as long as $dM/d\bar{P} > (dD_U/d\bar{P}_m)/(1 - q)$. 
Before proceeding to a full analysis of the various cases, four issues are examined: urban market segmentation, the marketable surplus, ration cards and queues, and the procurement price below the market price.

Urban Market Segmentation

Subbarao (1992), writing about the excessive cost and ineffectiveness of India's Public Distribution System, claims that no serious efforts were made to limit access to the system to only the most vulnerable groups. In fact, all urban consumers are issued ration cards (which are even used for identification). Hence, the urban rich have access to the ration shops. If they do not consume the product that is procured because of its poor quality (or because of the inconvenient location of the ration shop), then only the urban poor's demand for the procured product should be considered in the analysis.

If the urban rich do consume products that are procured and have equal access to the ration shops, the question remains as to whether they will choose to buy at the ration shops if queues are present. The value of time of the urban rich is higher than that of the urban poor; for the urban rich, then, the full cost of buying at the fair-price shops, including the value of their time, might be larger than the open-market price. However, the urban rich typically use the urban poor (servants) to stand in line for them and can thus obtain the procured output at the same cost as the urban poor. This is particularly true in India. The analysis thus considers both the case of perfect urban market segmentation between rich and poor (or perfect targeting) and the case of no market segmentation.

If farmers can adjust the quality of their products so as to sell a lower quality at the ration shops, then the gain to the poor of having access to the ration shops will fall, and so will the cost to the farmers. At the limit, if farmers are able to costlessly adjust quality to the lower, ration-shop price, then farm profits remain unchanged. And if low-income consumers are indifferent between better quality at the higher price (without the procurement policy) and lower quality at the lower price, then consumer welfare remains unchanged. In that case, the policy is totally ineffective. Of course, this requires that the quality-price tradeoff for consumers equal the quality-cost tradeoff for producers, and this is unlikely to hold over a large range. Thus, the ability to adjust quality will generally partially reduce the policy's effectiveness.

The same is true with evasion. If it can be done without cost, the policy will be ineffective. If it entails a cost, however, evasion will reduce the effectiveness of the policy, as when authorities close surplus states to interstate trade to limit evasion in times of drought. The analysis abstracts from the two issues of quality differences and evasion to keep the problem manageable and to enable a comparison with the findings of others, but the above qualifications should be kept in mind.

The Marketable Surplus

The marketable surplus, $M$, equals output, $S$, minus rural demand, $D_F$, or

\[ M = S(P) - D_F(P, \pi) \]
where $P$ is the price received by farmers and $\pi$ is the farmers' profits. Then

\[
\frac{dM}{dP} = \frac{dS}{dP} - \frac{dD_F}{dP} = \frac{dS}{dP} - \left( \frac{\delta D_F}{\delta P} + \frac{\delta D_F}{\delta \pi} \cdot \frac{\delta \pi}{\delta P} \right)
\]

since, by Hotelling's lemma, $\frac{\delta \pi}{\delta P} = S$.

Assuming the good to be normal, the effect $\frac{\delta D_F}{\delta \pi} S$ of an increase in $P$ is positive, and it is possible that $\frac{dD_F}{dP} > 0$. It is even possible that $\frac{dM}{dP} < 0$ if $\frac{\delta D_F}{\delta \pi} S > \frac{dS}{dP} - \frac{\delta D_F}{\delta P}$.\footnote{For small farmers for whom $M \leq 0$, $\frac{dM}{dP} > 0$.}

For subsistence crops in India, Krishna (1962) reports values for $d\log M / d\log S$ of 1.04 and 1.06. Since $d\log M / d\log S = (d\log M / d\log P) / (d\log S / d\log P) > 0$ and since the denominator $(d\log S / d\log P)$ is positive, $dM / dP > 0$. Most studies on developing countries also obtain positive values for $dM / dP$. Here the cases in which $dM / dP$ is negative, zero, and positive are considered, but the price elasticity of marketable surplus is assumed to be larger than the price elasticity of urban demand in order to ensure that the equilibrium is both unique and stable.

**Ration Cards and Queues**

Assuming that the procured amount is not sufficient to satisfy the demand at the below-market price and that the procured amount is rationed through ration cards, then those who have access to the procured output benefit from an intramarginal income gain. The relevant price (at the margin) for them (as well as for those who have no access to the rationed output) is the market price. This point is important for formulating the demand functions in the cases of a closed economy with and without market segmentation (see next section).

An alternative is the case of rationing by queuing. Supplies at the ration shops may not be sufficient to satisfy the rationed demand. This is relevant in several Indian states. For instance, Subbarao (1992) claims that in Andhra Pradesh, where coverage is wide, the public distribution system met only 34 percent of the minimum rice requirements of the poorest. For all grains, 2.5 million tons were required to fill the ration quotas of the poorest, but the state government provided only 1.7 million tons, and some of it went to other groups. By contrast, the states of Gujarat, Kerala, and Tamil Nadu have been quite successful in targeting the poor. Thus, the analysis without queuing may be more relevant for

\[
\frac{dD_r}{dP} = \frac{\delta D_r}{\delta P} + \frac{\delta D_r}{\delta \pi} S = \left[ \frac{\delta D_r}{\delta P} \left| \frac{\delta D_r}{\delta \pi} \right| D_r \right] + \frac{\delta D_r}{\delta \pi} S, \text{ or: } \frac{dD_r}{dP} = \frac{\delta D_r}{\delta \pi} \left| \frac{\delta D_r}{\delta \pi} \right| D_r + \frac{\delta D_r}{\delta \pi} M.
\]

The first term on the right is the substitution effect and is negative. Thus, if $M \leq 0$, $\frac{dD_r}{dP} < 0$ and $\frac{dM}{dP} > 0$.\footnote{For small farmers for whom $M \leq 0$, $\frac{dD_r}{dP} > 0$.}
targeting the poor. Thus, the analysis without queuing may be more relevant for those states. However, the situation is worse in some other states (Bihar, Rajasthan, Madhya Pradesh, and Uttar Pradesh), which account for a large share of India's poor but receive only a small share of supplies for the Public Distribution System. This has resulted in long queues. Hence, the analysis in the presence of queues is relevant for these states.

If queues are long enough to bring the effective price of rationed food (including the waiting cost) up to the open-market price, then under plausible conditions (positive price elasticity of marketable surplus and trade controls), the open-market price will rise and the average price will fall (see table 1). Then both consumers and producers will lose.

_The Procurement Price and the Open-Market Price_

Procurement for rice and sugar is generally carried out at the trader-processor level and is proportional to the marketable surplus that is sold by the farmer to the trader or processor. The price farmers receive is then a weighted average, \( \bar{P} \), of the procurement price, \( P_o \), and the open-market price, \( P_m \). \( \bar{P} \) is also the marginal incentive, because procurement is proportional. Then output, \( S \), marketable surplus, \( M \), and rural demand, \( D_F \), are all a function of \( \bar{P} \) and not of \( P_m \). This assumes that all farmers have a positive marketable surplus.

It has been argued that procurement is better modeled by assuming that a fixed amount is procured (rather than a fixed proportion), particularly for wheat. Then, the marginal incentive for farmers is \( P_m \), the open-market price. Since procurement lowers \( P_o \), \( P_m \) will always increase more than the average price, \( \bar{P} \) (or will decrease less). Therefore, with a positive price elasticity of marketable surplus \( M \), the impact on \( M \) will be larger when a fixed quantity is procured than when a fixed proportion is procured (assuming the amount procured to be the same in both cases). Thus, \( \bar{P} \) will always be lower when a fixed quantity (rather than a fixed proportion) is procured. The analysis in the next section assumes procurement is proportional. This results in an upward bias in the solution for \( \bar{P} \) compared with the assumption of fixed-quantity procurement, or in a bias in favor of the Dantwala (1967) and Hayami, Subbarao, and Otsuka (1982) result.

The distribution of gains and losses by farm size has been examined by Sah and Srinivasan (1988). The formal model abstracts from farm size and landless laborers, but these issues are examined in each case in the next section. Small farmers might have a negative marketable surplus, that is, they might be net buyers, and so would landless laborers. The relevant price at the margin would then be the open-market price or the procurement price, depending on the market to which the small farmer or landless laborer would have access. If purchases in the rural areas are made in the same proportion as in the urban areas, then the relevant price is also \( \bar{P} \).

If the procurement policy depresses the average price, \( \bar{P} \), then producers as a whole lose. However, small farmers who are net buyers gain, as do landless
laborers. And they especially gain if they have access to the ration shops in a proportion that is larger than in the urban areas, that is, if they pay less than the average price. However, to be net buyers, small farmers must earn extra income and be employed on other (larger) farms or must work in the nonfarm rural sector. Rural employment opportunities are generally related to agricultural incentives. A lower average producer price will depress rural employment opportunities. Hence, the impact on small farmers, and landless laborers, of a procurement policy that results in a lower average price will depend on the impact of the policy on rural wages.

II. PUBLIC PROCUREMENT AND DISTRIBUTION UNDER ALTERNATIVE ASSUMPTIONS

The effects of public procurement and distribution under alternative assumptions are analyzed for the following general cases: free trade, a closed economy with no rationing, a closed economy with rationing and market segmentation, and a closed economy with rationing and no market segmentation.

Free Trade

The procurement policy has generally been examined in a closed-economy setting. The issue of extending the process of industrial trade liberalization to the agricultural sector in India is part of the current policy debate. Such a process has already taken place in several developing countries. For free trade in a specific product and under the small-country assumption, the analysis is simple. The market price, $P_m$, is independent of the procurement policy. Therefore, the average price, $\bar{P}$, in the case of procurement is lower than the market price without procurement, because part of the crop is procured at a price $P_0 < P_m$.

Thus, farmers as a whole lose. Small farmers who are net buyers and landless laborers gain, unless the lower average price leads to lower rural wages, in which case the effect is ambiguous. Those urban consumers who have access to the procured output gain. No consumers lose. These results hold both in the short run (output $S$ given) and in the long run, with or without rationing, and with or without market segmentation between the urban rich and poor. However, with rationing by queuing, arbitrage may lead to such a long queue that the cost (inclusive of time) will be $P_m$ in both markets. (The reason for that is discussed below for a closed economy with rationing and market segmentation.) Then, no consumers gain (and net rural buyers who also must queue do not gain, and they lose if rural wages fall).

These results are summarized in the following.

Proposition 1. Under free trade and the small-country assumption, procurement has no impact on the open-market price ($P_m$), the average price ($\bar{P}$) falls, farmers as a whole lose (although small farmers and landless laborers who are net buyers may gain, depending on the impact of the price fall on the rural wage), no consumers lose, and those with access to the.
procured output gain. However, if procured output is rationed by queuing, consumers may not gain (and it is more likely that net rural buyers lose).

With drought and managed trade, the open-market price, $P_m$, rises. Governments have often closed the surplus states (to prevent them from exporting to the deficit states) to keep the procurement price low so that they can purchase the quantity needed. Governments have also often allowed larger imports in response to droughts when stocks were low or have sold stocks when they were large. Thus, the procurement policy has been applied most intensely precisely when supply has been most responsive (through imports or reduction in stocks), and the market has thus tended to be more open. Under these circumstances, the impact of such a policy is more likely to be a fall in the average producer price, $P$.

The analysis above assumes that the law of one price prevails. However, there is a gap between the free on board (f.o.b.) and cost, insurance, and freight (c.i.f.) prices at the port (say, Bombay for wheat) and even more so in the interior (say, the Punjab). Pursell and Gulati (1993) have estimated these margins for 1985-87. The difference in the c.i.f. and f.o.b. prices of rice was 5 percent at the port and 25 percent in the main surplus area (Punjab); the difference for wheat was 17 percent at the port and 43 percent in the main surplus area. Thus, even under free trade, the products might behave as nontradables within a certain price range. Then, the open-market price might increase with procurement, and the effect on the average price would be ambiguous. This is less likely to happen at the port where the price range is smaller (5 percent for rice) than in the hinterland.

The analysis proceeds under the assumption of a closed economy for the product analyzed. The results also hold when international trade in the product is managed by the government and is independent of the procurement policy.

**A Closed Economy with No Rationing**

Without rationing, there must be market segmentation between rich and poor. Otherwise, all consumers can buy at the procurement price, $P_o$, resulting in excess demand that will have to be rationed. Thus, the poor have unlimited access to the procured output at price $P_o$, and the rich can buy only in the open market, at price $P_m$. In this case, the procurement price is set by the authorities, but the quantity procured is determined endogenously by the fact that the authorities must meet the poor's demand.

Market equilibrium is given by

$$ M = S(\bar{P}) - D_R(\bar{P}, \pi(\bar{P})) = D_U(P_o, Y^p) + D_R(P_m, Y^r) $$

6. A possible exception is the case where the price elasticity of the marketable surplus is so negative that at the lower producer price, $P_o$, farmers release for urban consumption exactly the increase in urban demand or more. However, this raises problems of multiple equilibria and stability. Here it is assumed that the price elasticity of marketable surplus is larger (less negative) than the price elasticity of urban demand to ensure that the equilibrium is unique and stable. Then, market segmentation must hold with no rationing.
where \( \bar{P} = qP_o + (1 - q)P_m \) is the average price received by farmers on their marketable surplus, \( M \); \( q \) is the proportion of marketable surplus that is procured, \( q \) being equal to \( DP_u / M \) without rationing; \( D_i \) is urban demand by group \( j \), where \( j \) is \( P \) (poor) or \( R \) (rich); \( Y_i \) is the income of urban group \( j \); and \( \pi \) is rural profits.

The impact of a change in \( P_o \) on \( P \) and \( \bar{P} \) is derived in appendix A. The solution is given by equations A-3, A-5, and A-6. The sign of \( \frac{d\bar{P}}{dP_o} \) is ambiguous (see equation A-6). Therefore it follows from equation A-5 that \( dq/dP_o \) may be negative, zero, or positive, and it then follows from equation A-3 that \( dP_m/dP_o \) may be negative, zero, or positive. Thus, it is not even possible in a closed economy with no rationing to know the effect on the open-market price of a change in the procurement price. These results hold both in the very short run (output given) and in the long run.

If \( dM/d\bar{P} = 0 \), then \( dP_m/dP_o < 0 \) (\( P_m \) rises as \( P_o \) is reduced), but the sign of \( d\bar{P}/dP_o \) remains ambiguous. In this case, the urban rich lose because they buy only at \( P_m \), whereas the urban poor, who can satisfy their entire demand at the low \( P_o \), gain. The effect on the producers is ambiguous.

Starting from a situation of no procurement policy (\( P_o = P_m \)), under plausible assumptions, if \( dM/d\bar{P} \geq 0 \), then \( dP_m/dP_o < 0 \) and \( d\bar{P}/dP_o < 0 \). That is, a "small" application of the procurement policy increases the open-market price and the average price received by farmers. Setting \( P_m = P_o = 0 \) in equation A-6,

\[
\frac{d\bar{P}}{dP_o} = \frac{(1 - q) \frac{dD_p}{dP_0} - q \frac{DP_o}{dP_m} \bar{P}}{(1 - q) \frac{dM}{dP_o} - \frac{dD_p}{dP_m} \bar{P}} = \frac{A'}{B'}
\]

and from equation A-3

\[
\frac{dP_m}{dP_o} = \frac{\frac{dD_p}{dP_0} - q \frac{dM}{d\bar{P}} \bar{P}}{B'}.
\]

Assuming \( dM/d\bar{P} \geq 0 \), it follows that \( B' > 0 \) and \( dP_m/dP_o < 0 \). \( A' \) can be rewritten as

\[
A' = (1 - q) E^P \frac{D_p}{P_o} - q E^R \frac{D_p}{P_m} = \frac{D_p}{M} E^P \frac{D_p}{P_o} - \frac{D_p}{M} E^R \frac{D_p}{P_m}
\]

where \( E^j \) is the price elasticity of demand of group \( j \). Because \( P_m = P_o \), it follows that if the price elasticity of demand of the urban poor is larger than that of the urban rich, then \( A' < 0 \) and \( d\bar{P}/dP_o < 0 \). In the case of India, Radhakrishna, Murthy, and Shah (1979) have found that \( |E^P| = 0.8 > |E^R| = 0.4 \), so that \( d\bar{P}/dP_o < 0 \).
Thus, starting from a situation of no procurement policy \((P_0 = P_m)\), a “small” (infinitesimal) application of that policy (a “small” reduction in \(P_0\)) will result in an increase in \(P_m\) and \(\bar{P}\) as long as the price elasticity of the marketable surplus is nonnegative and the demand of the urban rich is less elastic than the demand of the urban poor. As is known from the theory of discriminating monopoly, a necessary condition for producers as a whole to gain is that consumers who are charged the higher price (the rich) have a less elastic demand. In this case, the policy leads to a price discrimination that benefits farmers as a whole. Net buyers in rural areas (small farmers and landless laborers) lose, unless the increase in the average producer price results in higher rural wages, in which case the effect is ambiguous. Rich urban consumers lose, and poor urban consumers gain.

These results are summarized in the following.

**Proposition 2.** In a closed economy with no rationing, the impact of procurement on \(P_m\) and \(\bar{P}\) is, in general, ambiguous. However, starting from \(P_m = P_0\) (no policy), a “small” application of the policy will raise \(P_m\) and \(\bar{P}\) if the elasticity of the marketable surplus is nonnegative and the demand of the urban poor is more elastic than the demand of the urban rich. In the latter case, farmers as a whole gain, the urban poor gain, and the urban rich lose. Net rural buyers (small farmers and landless laborers) lose unless rural wages increase, in which case the effect is ambiguous.

The result \(d\bar{P}/dP_0 < 0\) holds only locally, that is, around \(P_m = P_0\). This is essentially the result obtained by Hayami, Subbarao, and Otsuka (1982), whose model assumes no rationing, market segmentation, and a “small” application of the policy. As noted above, the result is ambiguous in the more general and interesting case where the change in \(P_0\) is “large” (for example, in the case of food shortages, where the market price would be significantly higher than the procurement price), unless further restrictions are imposed on parameter values or functional forms, or both.

For instance, assume that the demand of the urban rich is inelastic whereas that of the urban poor is elastic and that the marketable surplus is constant. Then any reduction in \(P_0\) will raise producer revenue both because of the larger sales to the poor at the lower ration-shop price \(P_0\) (elastic demand) and from lower sales to the rich at the higher price \(P_m\) (inelastic demand). Thus, revenue rises in both markets. Because total revenue rises and marketable surplus is given, \(\bar{P}\) must increase. The same result obtains if one of the two demand curves has an elasticity equal to one. However, Radhakrishna, Murthy, and Shah (1979) found an elasticity for the poor smaller than one (0.8). In that case, revenue from selling to the poor falls as the price falls. Thus, the impact on \(\bar{P}\) is ambiguous for discrete applications of the policy when the parameter values that have been reported for India are used. More precise numerical results for the discrete case are presented at the end of this subsection.
Why is the impact on the average price, $\bar{P}$, unambiguously positive in a closed economy with no rationing when the policy is applied infinitesimally but not for a discrete application of the policy? Assuming first that the marketable surplus, $M$, is given and does not vary with price, any increase in the consumption of the urban poor with access to the ration shops is matched by an equal decrease in consumption by the rich. Because the price elasticity of the rich is smaller than that of the poor, marginal revenue is larger for the poor than for the rich without intervention. Revenues are maximized by shifting consumption from the rich to the poor until marginal revenues are equal in both markets.

Thus, a small application of the procurement policy will increase total revenue and also the average price (because $M$ is given). However, a discrete application of the policy has an ambiguous effect because it might lead to a shift in consumption that is larger than the shift that maximizes revenues (so that the marginal revenue for the rich becomes larger than for the poor). This might result in lower revenues and a lower average price.

The fact that the marketable surplus increases with the average price cannot reverse these results. Assume the average price increases for a given marketable surplus. The higher average price leads to an increase in marketable surplus. This lowers the average price. However, the new equilibrium average price cannot be lower than without the policy because a lower average price would result in a lower, not larger, marketable surplus. Thus, a positive slope of the marketable surplus will dampen the effect of the procurement policy on the average price but will not reverse it.

Estimated parameter values for India can be used to obtain more precise results for a discrete application of the policy. As noted above, Radhakrishna, Murthy, and Shah (1979) found an elasticity of demand of 0.8 for the poor and 0.4 for the rich. For rice, the procured share has fluctuated between 60 and 80 percent since the late 1960s. Assuming a procured share of 80 percent and assuming linear demand curves for simplicity, the average producer price is maximized when the procurement price is 6.95 percent below the no-intervention price. The maximum average price is only 2.8 percent higher than the no-intervention price. And, when the procurement price is 13.9 percent below the no-intervention price, the average price is exactly equal to its no-intervention value. With a procured share of 60 percent, the maximum average price is 4.4 percent higher than the no-intervention price.7

Consequently, if with an 80 percent procurement share the procurement price were set at a level 14 percent or more below the no-intervention price, then the

---

7. Given the share procured (and therefore consumed by the urban poor), the price elasticities of demand, and the assumption of linear demand functions, both demand curves can be obtained (up to a scale factor related directly to $M$ and inversely to the no-intervention price). Then, marginal revenue functions can be obtained, and, given a fixed $M$, marginal revenues of the rich and the poor can be equated to obtain the maximum total revenue and maximum average price. That price is a function of the no-intervention price, and the proportional difference between the two can be obtained. Detailed derivations are available from the author.
policy would result in a lower average price, and the farm sector as a whole would lose. Even if the procurement price were set higher than 14 percent below the no-intervention price, the policy would at best result in a 2.8 percent increase in the average price. And this number rises to only 4.4 percent with a 60 percent procurement share. These results are obtained under the assumption that the marketable surplus, $M$, is given. If, as found, $M$ increases with the average price, then the maximum average price would be even lower than when $M$ is constant, but the point at which the average price starts falling below the no-intervention price would be the same.

For wheat, the procured share has averaged about 50 percent since the late 1960s. The maximum average price obtainable would be at most (with a given marketable surplus) 5.2 percent higher than the no-intervention price. This would occur when the procurement price is 20.8 percent below the no-intervention price. (And the average price would be lower than the no-intervention price when the difference between the procurement and no-intervention prices became larger than 41.6 percent.) Hence, even if the average price did increase because of the policy, the amount of increase would at best be negligible and would probably not reach 5 percent.

A Closed Economy with Rationing and Market Segmentation

In this case, both the procurement price and quantity are exogenous. The poor's demand, $D_P^r$, exceeds the supply provided by the ration shops. Hence, $D_P^r$ depends on $P_m$, the price of the marginal units, rather than on $P_0$. And $D_P^r$ depends not on $Y_P$ but on $y_p = Y_P + V$, which includes the value $V$ of having access to the rationed units at the lower price. The value $V$ depends on how the rationed units are distributed. If no more ration cards are distributed to the target population of urban poor than the supply available at the ration shops, there is no queuing, and $V = (P_m - P_0)Q_0$, where $Q_0$ is the procured and rationed output. If more ration cards are distributed than the supply available at the ration shops (the rationed demand exceeds the available supply), there are queues, and the value of the time waiting in line must be subtracted from the value of access to the rationed goods. The length of the line depends on the number of ration cards in relation to the available supply. However, the full cost of obtaining a unit of the product at the ration shop, including the value of waiting time, cannot be larger than the open-market cost, $P_m$. The reason for that is arbitrage, because the poor always have the choice of buying on the open market at the price $P_m$. The possibility of buying on the open market determines the maximum length of the queue when the full cost of buying the product is the same in both markets and $V = 0$ (and $y_p = Y_P$).

The analysis begins by assuming no queuing. In the absence of queuing, equation 3 becomes

\[ M = S(\bar{P}) - D_P[\bar{P}, \pi(\bar{P})] = D_P^r(P_m, y_p) + D_E^r(P_m, \bar{Y}_r) \]

where $\bar{P} = qP_0 + (1 - q)P_m$, and $q$ is the proportion of marketable surplus that is procured and $q = (Q_0/M)$ ($Q_0 < D_P^r$). The total income of the urban poor
(including the value \( V \) of the right of access to the rationed output \( Q_0 \) at the low price \( P_0 \)) is
\[
\gamma_p = Y_P + (P_m - P_0) q M = Y_P + (P_m - P_0) Q_0.
\]

The derivation of the effect of changes in \( P_0 \) on \( P_m \) and \( \bar{P} \) is presented in appendix B. The solution without queuing is given by equations B-3 and B-4. The signs of both \( d\bar{P}/dP_0 \) and \( dp_m/dP_0 \) are ambiguous. If \( dM/d\bar{P} = 0 \), then \( dp_m/dP_0 < 0 \), but the sign of \( d\bar{P}/dP_0 \) remains ambiguous. In this case, the urban rich lose while the poor may gain or lose (depending, for the case where \( \bar{P} \) rises, on the share they purchase on the open market at the higher price, \( P_m \)).

With queuing, the longer the queue, the lower the income gain, \( V \), to the urban poor. At the limit, \( V \) equals zero (\( \gamma_p = Y_P \)). Then, as shown in equation B-5, \( dp_m/dP_0 \leq 0 \) as long as \( dM/d\bar{P} \geq 0 \) or \( dM/d\bar{P} \leq (dD_U/dP_m)/(1 - q) \). And, as shown in equation B-6, \( d\bar{P}/dP_0 > 0 \) as long as \( dM/d\bar{P} > (dD_U/dP_m)/(1 - q) \). Thus, with a positive elasticity of marketable surplus, procurement will necessarily lead to a rise in \( P_m \) and to a fall in \( \bar{P} \). This is the worst scenario, because all three groups (urban rich, urban poor, and farmers as a whole) lose. Even if the elasticity of marketable surplus is negative, procurement can still lead to a fall in the average price received by farmers. And if \( dM/d\bar{P} = 0 \), then \( P_m \) remains unchanged and \( d\bar{P}/dP_0 = q \), that is, \( \bar{P} \) falls by a proportion \( q \) of the fall in \( P_0 \).

These results are summarized in the following.

**Proposition 3.** In a closed economy with rationing and market segmentation, if rationing is done without queuing, the impact on \( P_m \) and \( \bar{P} \) is, in general, ambiguous. If rationing is done by queuing, \( P_m \) will rise and \( \bar{P} \) will fall if the price elasticity of marketable surplus is positive (a sufficient but not necessary condition) and the queue is long (so that the full cost of buying at the ration shop approximates the open-market price). Then, the farm sector and all urban consumers lose. Net rural buyers (small farmers and landless laborers) would also lose, both because they would have to queue to obtain the rationed units and because the lower average producer price would probably result in lower rural wages.

What is the explanation for these outcomes? In a closed economy with no rationing and market segmentation, the effect on the average price was, in general, ambiguous. We compare that base case with the present one where the procurement price remains unchanged but the procured quantity is reduced (rationing) and there is no queuing. Then, the poor may buy additional units at the open market. In that case, the open-market price and the average price rise because of the higher demand. Also, a larger quantity is sold on the open market. This lowers the open-market price and the average price. Finally, the share sold in ration shops is lower, and the share sold on the open market is higher. This raises the average price. Thus, the net effect on the average price is

8. If the average price, \( \bar{P} \), remains unchanged or falls, then, since the urban rich pay \( P_m > \bar{P} \), the urban poor pay on average less than \( \bar{P} \) and therefore must gain. However, if \( \bar{P} \) rises, the urban poor may gain or lose.
unclear, and, since the effect in the base case was unclear as well, the outcome in this case is ambiguous. When there is queuing, the longer the queue and the larger the real income or welfare loss for the poor, the lower their demand and the lower the open-market price and the average price. At the limit, both the rich and the poor pay the open-market price. Then all consumers lose and so do the farmers (as long as the supply response is positive or at least not too backward-bending).

A Closed Economy with Rationing and No Market Segmentation

In this case, the procured price and quantity are exogenous, and the analysis only has to consider total urban demand, $D_U$. Assume rationing is done without queuing. Then, equations B-3 and B-4 become, respectively,

\[
\frac{dP_m}{dP} = \frac{dM}{dP} q \left[ \frac{1 - (P_m - P_0)^2}{dP} q \right] + \frac{dD_U}{dP} qM = \frac{A_1}{B_1}
\]

and

\[
\frac{dP}{dP} = \frac{q \left( \frac{dD_U}{dP_m} + \frac{dD_U}{dP} \right)}{B_1} = \frac{C_1}{B_1}
\]

where $y$ is urban income, including the value to the urban consumers of having access to $qM$ units at price $P_0$.

If $dM/dP \geq 0$, then $dP_m/dP_0 < 0$ and $dP/dP_0 > 0$. Let us first look at $C_1$. Since $M = D_U$, the term in parenthesis in equation 6 is simply the compensated price effect, and thus $C_1 < 0$. The sum of the first two terms of $B_1$ (the denominator in equations 5 and 6) is negative, since

\[
\frac{dD_U}{dP_m} + \frac{dD_U}{dP} qM < \frac{dD_U}{dP_m} + \frac{dD_U}{dP} M < 0.
\]

Thus, if $dM/dP = 0$, then $A_1 > 0$, $B_1 < 0$, $dP_m/dP_0 < 0$, and, since $C_1 < 0$, $dP/dP_0 > 0$.

This result also holds for $dM/dP > 0$. First, examine the term

\[
F = (P_m - P_0) \frac{dD_U}{dP} q - 1.
\]

($F$ is the bracketed term in $B_1$.) This can be rewritten as

\[
F = (P_m - P_0) \frac{Q_0}{M} - 1 = (P_m - P_0) \frac{Q_0}{D_U} - 1
\]

\[
= \frac{(P_m - P_0) Q_0}{y} E_U - 1
\]
where $E_Y$ is the income elasticity of demand for the urban consumers. For $F$ to be negative or zero, it must be the case that

$$E_Y \leq \frac{\gamma}{(P_m - P_0) Q_0} = \frac{Y + (P_m - P_0) Q_0}{(P_m - P_0) Q_0} = 1 + \frac{Y}{(P_m - P_0) Q_0}.$$

Now $Y$ is total urban income and is several times larger than $(P_m - P_0) Q_0$, the value of the property right to the $Q_0$ rationed units. Thus, $E_Y$ could be several times larger than 1, and $F$ would still be negative or zero.

For India, NCAER (1970) and Pandey (1973) report income elasticities, respectively, of 0.489 and 0.71 for foodgrains, and 0.616 and 0.79 for all cereals. Pandey reports an income elasticity for rice of 1.06. The grain, oilseeds, and livestock study of the U.S. Department of Agriculture reports income elasticities of 0.70 for rice and 0.70 for wheat. These results imply that $F < 0$.

Since the sum of the first two terms of $B_1$ (the denominator in equations 5 and 6) is negative, if $F \leq 0$ and $dM/dP \geq 0$, then $B_1$ is negative. Since $C_1 < 0$, $dP/dP_0 > 0$. Also,

$$A_1 = \frac{dM}{dP} q(-F) + \frac{dD_m}{dy} qM > 0$$

and thus $dP_m/dP_0 < 0$.

Thus, if the policy does not differentiate between the urban rich and the urban poor, and if $dM/dP \geq 0$, then the procurement policy, which implies a reduction in $P_0$, will increase the open-market price, $P_m$, but will decrease the average price, $P$, received by farmers. Under these circumstances, farmers lose on average and consumers gain on average. If the income elasticity of demand for the procured products is zero and if the urban rich have the same access to the ration shops as the urban poor, then both the urban rich and the urban poor will buy the same proportion at price $P_0$ and at price $P_m$, that is, on average they will both pay $P$. Hence, they will both gain. If, as has been found, the income elasticity for these products in urban areas of developing countries is positive, the rich will buy a larger share at $P_m$ than the poor. Hence, the poor will gain, and the rich may or may not gain.

The fall in $P$ holds even more strongly if rationing is done by queuing and can hold even for a negative elasticity of marketable surplus (see equation B-6 in appendix B). Thus, farmers as a whole also lose in this case. At the limit, $V = 0$. Then, once the cost of waiting is taken into account, all consumers pay $P_m$, so both the urban poor and the urban rich lose. Hence, in this case, every group loses from the procurement policy.

These results are summarized in the following.

**Proposition 4.** In a closed economy with rationing and no market segmentation, $P_m$ rises and $P$ falls if the price elasticity of the marketable surplus is nonnegative. This is true whether rationing occurs with or without queuing. Without queuing, the urban poor gain, and the urban rich may gain or
lose. With long queues, all urban consumers lose. Farmers lose as a whole. However, without queuing, the net buyers (small farmers and landless laborers) gain, unless the lower average price results in a lower rural wage, in which case the effect is ambiguous. With queues, net rural buyers are more likely to lose.

Under India's Public Distribution System, ration cards are distributed to the urban poor as well as to the rich, and buyers at ration shops have to queue. The analysis here indicates that if the rich have equal access to the ration shops, procurement should decrease the average price paid to farmers as long as the price elasticity of the marketable surplus is nonnegative (see lower left corner of table 1).

Sah and Srinivasan (1988) examine the impact of procurement on welfare in a model of utility-maximizing agents with a continuum of farm sizes and urban incomes. They also assume rationing and no market segmentation. They find that the market price increases with a small amount of procurement, but they do not report the impact on the average price. They also show that the urban poor gain and that the rural poor lose. They do not consider the possibility of queuing or of changes in rural wages; rather, they examine the case of tradable rations. In the latter case, and with a linear Engel curve for food, the open-market price is unchanged, the urban poor gain, and the farm sector loses. This result is also obtained by Binswanger and Quizon (1984). They use a general equilibrium model of the Indian economy to simulate alternative price policies. With forced procurement and equal access to the ration shops by all urban groups, they find that the impact on $P$ is negative.

III. SUMMARY AND CONCLUSIONS

This article examined the effect of the policy of government procurement of agricultural products on the open-market price and on the average price received by farmers under various circumstances. It analyzed the impact of the policy on the urban rich, the urban poor, and the farmers. Four general cases were analyzed.

So far, India's trade liberalization process has mainly affected industry, but the argument for free trade in agricultural products is being debated by the government. Thus, the first case analyzed was that of free trade. In this case, the open-market price is unaffected by the procurement policy, and the average price falls, irrespective of whether or not the procured output is rationed or targeted to the poor. Farmers as a whole lose, the urban poor gain, and the urban rich gain if they have access to the procured output. These results are weakened if the range between the c.i.f. and the f.o.b. price is large.

The second case was a closed economy with no rationing, in which, if the urban poor can satisfy their demand at the procurement price, the effect of the policy on the open-market price and on the average price is generally ambiguous. However, starting from the open-market price with no procurement policy
and if marketable surplus increases with the average price, then a "small" application of the policy increases the open-market price and the average price as long as the demand of the urban rich is less price-elastic than the demand of the urban poor. Farmers as a whole and the urban poor gain, but the urban rich lose. The rural poor (small farmers who are net buyers and landless laborers) lose if they pay the average price but might gain if they buy mostly at the ration shops and if queues are short. Moreover, the effect depends also on the impact of the higher average price on rural wages. With a discrete application of the policy, the effect on the average price is ambiguous; and if the effect is positive, it probably will not raise the average price by more than 5 percent compared with the no-intervention price.

The third and fourth cases were closed economies with rationing and with and without market segmentation, respectively. If the urban poor cannot satisfy their entire demand at the procurement price and the rationing is with ration cards without queuing, the effect of the policy on the open-market price and the average price is ambiguous. The price effect of the policy is not ambiguous if the policy does not differentiate between the urban poor and urban rich (or unless the rich do not consume the product) and the price elasticity of marketable surplus is nonnegative. Then, the policy increases the open-market price and decreases the average price. Farmers as a whole lose, the rural poor gain (unless the lower average price lowers rural wages, in which case the effect is ambiguous), the urban poor gain, and the urban rich may gain or lose. If rationing is by queuing and the queue is long, then the policy increases the open-market price if the price elasticity of the marketable surplus is positive. The policy causes the average price to fall even if the price elasticity of the marketable surplus is negative. All groups lose in this case.

As long as the procurement policy is not applied infinitesimally, there is no indication that it increases the average price as predicted by Dantwala (1967) and Hayami, Subbarao, and Otsuka (1982). The effect on the average price is ambiguous or negative, except where there is a closed economy with no rationing to the urban poor, perfect market segmentation between urban rich and urban poor, marketable surplus that does not fall with price, price elasticity of demand for the urban poor larger than for the rich, and a procurement policy that is applied infinitesimally. Only under those conditions is the effect on the average price unambiguously positive, although it is very small.

Hayami, Subbarao, and Otsuka (1982) assume the conditions of no rationing to the urban poor and perfect market segmentation between the urban rich and urban poor in their analysis. At the same time, they state that India's distribution system results in long queues and is unable to differentiate between the urban rich and urban poor (p. 655). If their description of the operation of the policy is correct, then our analysis indicates that procurement decreases the average price (lower left corner of table 1). Thus, a policy that was designed to help the urban poor may very well have hurt the farm sector as a whole, although it may have helped the rural poor.
By setting producer prices equal to consumer prices, we have implicitly assumed that transaction costs are the same in the private and public distribution systems. However, it seems plausible to assume higher costs for the public distribution system. In a recent study on India’s agricultural policies, Sharma (1991) found that, for wheat, the cost of public distribution was twice as high as the cost of private distribution. If so, the probability that the average price paid to farmers rises with the procurement policy is even lower. Moreover, the consumer benefits associated with the procurement policy also fall in this case. The opposite is true if explicit budgetary funds are provided to finance the policy.

Targeting to the urban poor has been mixed, to say the least, with some states more successful than others. In the more successful states (Gujarat, Kerala, and Tamil Nadu), the situation is closer to that of a closed economy with rationing and market segmentation, where the effect of procurement on the average price is ambiguous unless queues are long, in which case the effect is negative. In the states where targeting is less successful (Bihar, Rajasthan, Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh), the situation is closer to that of a closed economy with rationing and no market segmentation, where the effect on the average price is negative (with or without queuing). Thus, under the conditions likely to prevail in India, there is no presumption that procurement will increase the average producer price.

APPENDIX A. **THE IMPACT OF A CHANGE IN THE PROCUREMENT PRICE ON THE OPEN-MARKET PRICE AND THE AVERAGE PRICE IN A CLOSED ECONOMY WITH NO RATIONING**

From equation 3,

\[
\frac{dM}{dP_0} = \frac{dD_U^p}{dP_0} + \frac{dD_S^p}{dP_0}
\]

or

\[
\frac{dM}{dP} \frac{dP}{dP_0} = \frac{dD_U^p}{dP_0} + \frac{dD_S^p}{dP_m} \frac{dP_m}{dP_0}.
\]

Using the definition of \(P\)

\[
\frac{dP}{dP_0} = q + (1 - q) \frac{dP_m}{dP_0} + \frac{dq}{dP_0} (P_0 - P_m)^9
\]

and from equations A-1 and A-2,

\[
\frac{dM}{dP} \left[ q + (1 - q) \frac{dP_m}{dP_0} + \frac{dq}{dP_0} (P_0 - P_m) \right] = \frac{dD_U^p}{dP_0} + \frac{dD_S^p}{dP_m} \frac{dP_m}{dP_0}
\]

9. With no rationing, \(q\) is endogenous. It cannot be determined by the government independently of the level of \(P_0\), because the entire demand of the urban poor \(D_U^p\) must be satisfied at the price \(P_0\).
or
\[
\frac{dP_m}{dP_0} = \frac{dP_U}{dP_0} - \left[q + \frac{dq}{dP_0} (P_0 - P_m)\right]\frac{dM}{dP}.
\]

(A-3)

The sign of \(dP_m/dP_0\) cannot be examined until \(d\bar{P}/dP_0\) has been solved, because

\[
\frac{dq}{dP_0} = \frac{d(D_U/M)}{dP_0}
\]

depends on it.

From equations A-2 and A-3,

\[
\frac{d\bar{P}}{dP_0} = q + (1 - q) \frac{dP_U}{dP_0} - \left[q + \frac{dq}{dP_0} (P_0 - P_m)\right]\frac{dM}{dP} + \frac{dq}{dP_0} (P_0 - P_m)
\]

or

\[
\frac{d\bar{P}}{dP_0} = \frac{(1 - q) \frac{dP_U}{dP_0} - \left[q + \frac{dq}{dP_0} (P_0 - P_m)\right]\frac{dM}{dP}}{(1 - q) \frac{dM}{dP} - \frac{dD_U}{dP_m}}.
\]

(A-4)

Since \(q = D_U/M\),

\[
\frac{dq}{dP_0} = \frac{dD_U/M - D_U \frac{dM}{dP_0}}{M^2} = \frac{dD_U/M - D_U \frac{dM}{\bar{P}} \frac{d\bar{P}}{dP_0}}{M^2}
\]

(A-5)

From equations A-4 and A-5,

\[
\frac{d\bar{P}}{dP_0} = \frac{(1 - q) \frac{dP_U}{dP_0} + \left[\frac{(P_m - P_0)}{M} \frac{dD_U}{dP_0} - q\right]\frac{dD_U}{dP_m}}{(1 - q) \frac{dM}{dP} - \frac{dD_U}{dP_m} - \frac{D_U}{M^2} \frac{dM}{\bar{P}} (P_0 - P_m) \frac{dD_U}{dP_m}} = \frac{A}{B} < 0.
\]

(A-6)
APPENDIX B. THE IMPACT OF A CHANGE IN THE PROCUREMENT PRICE ON THE OPEN-MARKET PRICE AND THE AVERAGE PRICE IN A CLOSED ECONOMY WITH RATIONING AND MARKET SEGMENTATION

From equation 4,

\[
\frac{dM}{dP} = \frac{dD_U}{dP} + \frac{dD_R}{dP}
\]

or

\[
\frac{dM}{dP} \frac{dP}{dP} = \frac{dD_U}{dP} \frac{dP}{dP} + \frac{dD_R}{dP} \frac{dP}{dP}
\]

or

\[
\frac{dM}{dP} \frac{dP}{dP} = \frac{dD_U}{dP} \frac{dP}{dP} + \frac{dD_R}{dP} \frac{dP}{dP} q \left[ \left( \frac{dP_m}{dP} - 1 \right) M + (P_m - P_0) \frac{dM}{dP} \frac{dP}{dP} \right]
\]

where

\[
D_U = D_U + D_R
\]

Thus,

(B-1) \[ \frac{dM}{dP} \frac{dP}{dP} \frac{1}{dP} - (P_m - P_0) \frac{dD_U}{dP} \frac{dP}{dP} = \frac{dD_U}{dP} \frac{dP}{dP} + \frac{dD_R}{dP} \frac{dP}{dP} q \left( \frac{dP_m}{dP} - 1 \right) M. \]

With rationing, q can be determined independently of P_0. Assuming that q is given, and examining the effect of a change in P_0, then

(B-2) \[ \frac{dP}{dP} = q + (1 - q) \frac{dP_m}{dP}. \]

From equations B-1 and B-2,

\[
\frac{dM}{dP} \left[ q + (1 - q) \frac{dP_m}{dP} \right] \left[ 1 - (P_m - P_0) \frac{dD_U}{dP} \frac{dP}{dP} q \right] = \frac{dD_U}{dP} \frac{dP}{dP} + \frac{dD_R}{dP} \frac{dP}{dP} q \left( \frac{dP_m}{dP} - 1 \right) M
\]

or

(B-3) \[ \frac{dP_m}{dP} = \frac{dD_U}{dP} \frac{dP}{dP} q \left[ 1 - (P_m - P_0) \frac{dD_U}{dP} \frac{dP}{dP} q \right] + \frac{dD_R}{dP} \frac{dP}{dP} qM \]

\[
= \frac{A_0}{B_0} < 0.
\]
From equations B-2 and B-3,

(B-4) \[
\frac{dP}{dP_0} = \frac{q \left( \frac{dD_U}{dP} + \frac{dD_U}{dP_m} \right)}{B_0} \leq \frac{C_0}{B_0} < 0.
\]

For rationing by queuing, \( V = 0 \), and \( y_p = y_p \). Equations B-3 and B-4 then become

(B-5) \[
\frac{dP}{dP_0} = \frac{(dM/dP)q}{dD_U/dP_m - (1 - q)dM/dP} < 0 \quad \text{if} \quad \frac{dM}{dP} > 0 \quad \text{or if} \quad \frac{dM}{dP} < \frac{dD_U/\left(1 - q\right)}{dP_m}
\]

and

(B-6) \[
\frac{dP}{dP_0} = \frac{q \frac{dD_U}{dP_m}}{dD_U/dP_m - (1 - q)dM/dP} \geq 0 \quad \text{if} \quad \frac{dM}{dP} \geq \frac{dD_U/\left(1 - q\right)}{dP_m}
\]

If \( dM/dP = 0 \), then \( dP/dP_0 = q \).

REFERENCES

The word “processed” describes informally reproduced works that may not be commonly available through library systems.


Domestic Content and Compensatory Export Requirements: Protection of the Motor Vehicle Industry in the Philippines

Wendy E. Takacs

The motor vehicle industry in the Philippines is protected by a virtual embargo on the importation of new vehicles but operates under the burden of domestic content and compensatory export requirements that protect Philippine producers of automotive components. This article develops a model to assess the net impact of this complicated protective regime. Estimates indicate substantial benefits to the assembly and components industries and losses to vehicle purchasers. Reform of the system to eliminate the embargo as well as the domestic content and compensatory export restraints at current tariff rates would benefit vehicle purchasers but would increase the effective rate of protection to assembly operations by decreasing prices of components. Reform measures to eliminate the domestic content and compensatory export requirements should be accompanied by simultaneous reductions in tariffs on assembled vehicles.

The motor vehicle protective regime in the Philippines is made up of a complicated set of regulations. Imports of assembled vehicles are prohibited, with certain exceptions. Imports of sets of components (kits) to be assembled within the country are subject to tariffs. Firms are constrained as to the number of models produced and the amounts of imported, compared with domestic, components used. Also, firms assembling motor vehicles in the Philippines must export automobile industry products equal to given percentages of the value of imported kits.

Similar protective regimes have been used in several countries, especially in Latin America. The set of restrictions affects both the sales price of the finished vehicles and the cost conditions of domestic assembly operations. The restriction on imports of assembled vehicles drives up the domestic prices of motor vehicles.


Wendy E. Takacs is with the Department of Economics at the University of Maryland, Baltimore. This article was prepared while the author was a consultant with the Policy Research Department at the World Bank. She would like to thank Eric Abalahin for research assistance and Renato Schulz, Erika Jorgensen, and the anonymous referees for numerous suggestions.

©1994 The International Bank for Reconstruction and Development / THE WORLD BANK
vehicles, encouraging domestic production, but the local content requirements and export requirements increase the cost of production for assembly operations. The protective regime and regulations impose costs on consumers and misallocate resources, encouraging high-cost domestic production.

This article develops a model to illustrate the economic impact and welfare cost of the import prohibition, local content requirements, and export requirements in the motor vehicle industry and then applies that model to Philippine data to generate rough estimates of the cost to the country of maintaining this type of protective regime. Section I outlines the protective regimes in the industry in the Philippines since 1949. Section II develops a model to illustrate the impact of the current protective regime. Section III uses that model to explain the transfers among groups, inefficiencies, and net welfare costs arising from the protection. Section IV applies the model to Philippine data. Section V investigates alternative liberalization scenarios. Section VI offers conclusions and policy recommendations.

I. The Protective Regime for the Motor Vehicle Industry

The origins of the Philippine motor vehicle assembly industry can be traced back to 1949, when a shortage of foreign exchange led the government to impose foreign exchange controls. These controls denied foreign exchange to “nonessential” items, including passenger cars. By 1951, firms began assembling passenger cars in the Philippines from imported sets of components, or “kits.” Another foreign exchange crisis and a desire to promote the motor vehicle sector prompted the government to further regulate the industry in 1973 by continuing to prohibit the importation of completely built-up (CBU) vehicles and by imposing local content requirements. In 1984 the program was revised to add export requirements: firms assembling cars had to earn foreign exchange by exporting to partially compensate for the foreign exchange used to import kits.

Table 1. Local Content Requirements for Motor Vehicles Made in the Philippines, 1988–90

(percentage of total parts and components)

<table>
<thead>
<tr>
<th>Program and category</th>
<th>1988</th>
<th>1989</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car development program</td>
<td>32.26</td>
<td>36.58</td>
<td>40.00</td>
</tr>
<tr>
<td>Commercial vehicle development program</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category I</td>
<td>43.1</td>
<td>51.2</td>
<td>54.8</td>
</tr>
<tr>
<td>Category II</td>
<td>35.6</td>
<td>41.6</td>
<td>44.4</td>
</tr>
<tr>
<td>Category III</td>
<td>16.8</td>
<td>20.3</td>
<td>21.9</td>
</tr>
<tr>
<td>Category IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6,001–9,000 kilograms</td>
<td>16.5</td>
<td>19.9</td>
<td>21.4</td>
</tr>
<tr>
<td>9,001–12,000 kilograms</td>
<td>17.1</td>
<td>20.6</td>
<td>22.2</td>
</tr>
<tr>
<td>12,001–15,000 kilograms</td>
<td>10.7</td>
<td>12.6</td>
<td>13.5</td>
</tr>
<tr>
<td>15,001–18,000 kilograms</td>
<td>10.9</td>
<td>12.9</td>
<td>13.8</td>
</tr>
</tbody>
</table>

a. Category I, all Asian utility vehicles up to 3,000 kilograms gross vehicle weight (GvW); category II, all light commercial vehicles up to 3,000 kilograms GvW; category III, all vehicles from 3,001 to 6,000 kilograms GvW; and category IV, all vehicles from 6,001 to 18,000 kilograms GvW.

Table 2. Compensatory Export Requirements of the Motor Vehicle Industry in the Philippines, 1988–93

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of implicit export requirementa</th>
<th>Commercial vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>required exports that must be automotive products</td>
<td>Cars</td>
</tr>
<tr>
<td>1988</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1989</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>1990</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>1991</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>1992</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>1993</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

*Note:* The compensatory export requirement is the percentage of the value of imported kits that the firm is required to earn through exports. For the car development program, firms are required to earn foreign exchange from exports equal to 50 percent of the value of imported kits; for the commercial vehicle development program, the compensatory export requirement is 25 percent.

a. The percentage of the value of imported kits that is equal to the value of required automobile exports.

The administration that took power in 1986 adopted a new program the following year, patterned after the earlier protective regime. This program continued to ban imports of CBU vehicles competing with domestic production, increased the local content requirements year by year, and phased out the use of nonautomotive exports to meet export requirements. Table 1 lists the content requirements by type of vehicle under this new regime. Firms assembling cars are required to earn 50 percent of the foreign exchange needed to import kits, and firms assembling commercial vehicles must earn 25 percent of the foreign exchange needed to import kits. As shown in column 1 of table 2, credit for nonautomotive exports was gradually phased out, so that by 1993 only exports of automotive products qualified for the compensatory export requirements.

II. A MODEL OF THE PROTECTIVE REGIME IN THE MOTOR VEHICLE INDUSTRY

This section develops a model to assess the impact of the import prohibitions and domestic content and export requirements and the interactions among them. The model simplifies the situation by ignoring differentiation among types of components, the tradeoff between domestic content and compensatory exports allowed in the regime, regulations on minimum disassembly of components in kits, and prohibitions against importing certain components. The model assumes that the domestic content requirements and all export requirements are binding (that is, more assembled vehicles would be imported if there were no embargo, less domestic content would be used by assembly firms if

2. Increased use of local components over and above the prescribed percentages for local content is encouraged by an incentive scheme in which a firm receives additional foreign exchange credits equal to the foreign exchange equivalent of the value added of the local components.
there were no domestic content requirements, and exports of auto industry products would be less than the observed values without export requirements). The assumption of increasing costs and competitive markets in this model may appear unrealistic, given that the motor vehicle industry is frequently cited as an example of an industry with economies of scale and oligopolistic market structure. However, the automobile industries in developing countries are essentially assembly operations. The imported kits normally contain the components produced under economies of scale, such as stamped body parts and engines. Up-front design and engineering costs, which, spread over large volumes of output, contribute to economies of scale in production, are paid by the company abroad producing the kits. The assembly operations unpack the components from the kit and assemble them, incorporating local components produced using labor-intensive, low-technology processes in which economies of scale are less important. The domestic demand for replacement parts also helps components producers take advantage of the economies of scale that may exist. In addition, the assumption of competition in the motor vehicle assembly industry may be less unrealistic for the Philippines than for most developing countries. In the Philippines there are 8 car assembly firms and 26 commercial vehicle assemblers participating in the Motor Vehicle Development Program.

If the country imposing the domestic content and compensatory export requirements is small, the world price, or import price, of assembled vehicles and of components can be taken as given. Assume there is only one type of finished or assembled vehicle, made by assembling a given number of components. Ignoring differences among components for the moment, a perfectly competitive domestic components industry manufactures components and a perfectly competitive domestic industry assembles vehicles by combining packages of imported components, called “kits,” with domestically produced components. Assembly firms must earn a given percentage of the foreign exchange necessary to import the kits by exporting auto industry products. Equilibrium prices and

3. If no assembled vehicles would be imported even without the embargo, firms would use more domestic content than the minimum required if unconstrained, and profit-maximizing firms would export more automotive products than specified by the compensatory export requirements, then none of the constraints in the protective regime would be binding and the regime would have no effect.

4. The relatively large number of official participants in the Motor Vehicle Development Program resulted from a liberalization of the program in 1990 to allow for the entry of new firms in the “people’s car” category. In 1990, the base year for the estimation, the new entrants had not yet begun to operate. The three assemblers of passenger cars had rapidly changing market shares: in 1989 the shares were 29, 33, and 38 percent; in 1991, they were 51, 24, and 24 percent (see Guy and Mayo 1991). Although the competitive model may be adequate for the Philippine market with the new entrants, work is now under way on the impact of domestic content and compensatory export requirements in a market with fewer firms and where economies of scale and strategic interactions among firms are important. This model will provide a richer analysis than, and interesting comparisons with, the results of the competitive model presented here.

5. This approach is similar to the one used by Grossman (1981) in assuming that domestic and imported components are perfect substitutes. Mussa (1984) develops a model in which domestic and imported inputs are less than perfectly substitutable.
quantities in the market for assembled vehicles and in the market for components will be determined jointly because they are tied together not only by the normal input-output relations, but also by the domestic content and compensatory export requirements.

The Domestic Market for Assembled Vehicles

Given the prohibition on imports of assembled vehicles, the price of vehicles is determined by domestic demand and supply. Suppose that the quantity demanded \( \hat{Q}_A \) is a decreasing function of the price of a vehicle \( P_A \):

\[
\hat{Q}_A = D(P_A), \quad D' \text{ negative.}
\]  

On the supply side, suppose that there is an upward-sloping supply function of value added in domestic assembly operations, in which the quantity of vehicles that firms are willing to assemble increases as the value added per unit \( V \) increases, as in equation 2:

\[
V = V(Q_A), \quad V' \text{ positive}
\]

where \( Q_A \) is the quantity of finished vehicles produced.

Suppose that the assembly technology requires a certain number of components, \( \alpha \), per vehicle. Let \( \delta \) be the proportion of total components that must be of domestic origin. If 20 percent domestic content is required, then \( \delta = 0.2 \). Let \( x_K \) be the compensatory export requirement for kits, that is, the proportion of the value of the imported kit that must be compensated for by exports. Then \( \alpha(1 - \delta)P^e_C \), where \( P^e_C \) is the price of imported components, is the value of a kit at world market prices. Given the compensatory export requirements, the value of compensatory exports required to import each kit would be \( x_K\alpha(1 - \delta)P^e_C \). If components are bought (produced) at the domestic market price (cost) \( P_C \) but exported and sold at the world price \( P^e_C \), the cost to the firm of complying with the export requirements is \( (P_C - P^e_C)x_K\alpha(1 - \delta)Q_A \). The tariff on kits, \( t_K \), would increase the cost of kits to the domestic assembly industry by the tariff revenue that would have to be paid per kit, or \( \alpha(1 - \delta)P^e_C t_K \). The cost of domestic components would equal \( \alpha\delta P_C \), where \( P_C \) is the domestic price of components. The assumption of a perfectly competitive assembly industry implies that in the long run unit cost equals price, so

6. This approach is similar to the one used by Corden (1971, chap. 3).

7. Grossman (1981) shows that the domestic content requirements will have different effects if defined in terms of physical quantities or value added. The Philippine local content requirements can be treated as similar to a restriction in quantity terms. The contribution for each part is based on "points," equal to the ratio of the free on board CKD price of the part to the CKD full pack price of the vehicle model. The valuations are based on world prices, not domestic prices, so price increases for domestic parts will not reduce the quantity of domestic parts required to fulfill the domestic content requirements.

8. The extra cost of complying with the export requirements was at times explicitly recognized by multinational firms. Bennett and Sharpe (1985: 186) report that Chrysler arranged for its Mexican assembly operations to transfer funds to its U.S. assembly operation to cover the extra cost of Mexican parts.
\[ P_A = \alpha(1 - \delta)P_C^e[1 + t_K + \pi K(P_C - P_C^e)/P_C^e] + \alpha \delta P_C + V(Q_A^e). \]

Let \( \pi = (P_C - P_C^e)/P_C^e \) be the percentage by which the prices of domestic components exceed the prices of imported components. The above equation can then be written:

\[(3) \quad P_A = \alpha P_C^e(1 - \delta)(1 + t_K + \pi K) + \alpha P_C^e \delta(1 + \pi) + V(Q_A^e). \]

Equation 3 can be thought of as the long-run inverse supply curve for the assembly industry. Supply price is the (vertical) sum of the domestic value added that would be required for firms to be willing to assemble various quantities of vehicles, the cost per vehicle of domestic components used as intermediate inputs \( [\alpha P_C^e \delta(1 + \pi)] \), and the effective cost of the imported kit, which would equal \( \alpha P_C^e(1 - \delta)(1 + t_K + \pi K) \).

If importation of assembled vehicles is prohibited, then the interaction of the demand for, and supply of, vehicles from domestic assemblers will determine market price. The equilibrium in the domestic market would occur where the quantity demanded equals the quantity supplied:

\[(4) \quad Q_A^d = Q_A^s. \]

Equations 1 to 4 determine \( P_A, Q_A^d, Q_A^s, \) and \( V \), given \( P_C^e, t_K, \pi, \alpha, \) and \( \delta \), and holding \( P_C \) constant.

The market for assembled autos is shown in figure 1. The demand curve for assembled vehicles is shown by \( D_A \). The supply curve of the domestic assembly

Figure 1. The Market for Assembled Vehicles under the Current Protective Regime
operations is shown by $S_A$. As explained in more detail in section III, $S_A$ is the vertical sum of the supply curve under free trade, $S^*_A$, the increase in assembly industry costs per vehicle caused by the tariff, $\alpha P_c^*(1 - \delta)t_K$, and the increase in costs attributable to the domestic content and compensatory export requirements, $\alpha P_c^*[\delta\pi + (1 - \delta)x_K\pi]$.

Given the domestic supply and demand conditions, the equilibrium price of vehicles in the domestic market would be determined where the quantity produced ($Q_A$) equals quantity demanded. The domestic price ($P_A$) is not constrained by the price of a vehicle in the world market ($P^*_A$) because imports are prohibited.

The Domestic Market for Components

Assume that the perfectly competitive domestic components industry has a supply curve for components, given in inverse form by

\[
P_C = S(Q_C), \quad S' \text{ positive}
\]

where $Q_C$ is the quantity of components supplied by the domestic industry. The demand for domestic components includes the demand for components to be combined with imported kits for domestic assembly ($\alpha\delta Q_A$) and exports of components as compensatory exports for importing kits, $x_K\alpha(1 - \delta)(P_C^*/P_C)Q_A$. Thus the total demand for components can be expressed as

\[
Q_C = x_K\alpha(1 - \delta)Q_A(P_C^*/P_C) + \alpha\delta Q_A.
\]

Equations 5 and 6 determine $P_C$ and $Q_C$, given $P_C^*$, $x_K$, $\alpha$, and $\delta$, and holding $Q_A$ constant.

The equilibrium in the market for components is shown in figure 2. The supply curve of the domestic components industry is shown by $S_C$ and the demand curve for components by $D_C$. Equilibrium in the components market would occur at the price/quantity combination $P_C$ and $Q_C$.

Under free trade, domestic producers would be forced to match the world market price of components $P_C^*$, at which price the domestic production of components would be $Q_C^*$. Both the domestic content and compensatory export requirements increase the demand for components produced within the country, driving up price and production.

Given the links between the markets for domestic components and assembled vehicles, equations 1 to 6 jointly determine the endogenous variables $P_A$, $Q_A^*$, $Q_A$, $V$, $P_C$, and $Q_C$, given the world market price of components $P_C^*$, the technical coefficient $\alpha$, and the policy parameters $t_K$, $x_K$, and $\delta$. The equilibrium prices and quantities in both markets would be determined simultaneously.

III. Transfers among Groups and the Net Cost of the Protective Regime

If there were no protective regime, and abstracting from transportation costs, the world market prices of both assembled autos and components would prevail
Figure 2. The Market for Components under the Current Protective Regime

within the respective domestic markets. In the components market, a quantity $Q_c^*$ would be produced at the price $P_C^*$. The domestic assembly operations would have access to components at this price, so their supply curve would be the vertical sum of the value added per unit required for each output level and the cost of component inputs, $aP_C$. This supply curve is shown by $S_A$ in figure 1. At the free-trade price, $P_A$, the domestic industry would assemble $Q_A$ units, and consumers would purchase $D_A$ units; $D_A - Q_A$ assembled vehicles would be imported.

The costs of the entire protective regime can be assessed using the free-trade equilibrium as a benchmark for comparison. The tariff on kits, the domestic content requirements, and the compensatory export requirements increase input costs to assemblers and thus shift their supply curve upward from $S_A$ to $S_A'$. This upward shift can be decomposed into the cost increase per unit assembled as a result of the tariff, $aP_C^*(1 - \delta)x_K$ [cf in figure 1], and the upward shift caused by the domestic content and compensatory export requirements, $aP_C(\delta x) + (1 - \delta)x_K\pi$ [be in figure 1]. Let $S_A'$ show the industry supply curve with the tariff, but without the domestic content and compensatory export requirements. Thus the shift from $S_A$ to $S_A'$ represents the impact of the tariff on kits, and the shift from $S_A'$ to $S_A$ represents the impact of the domestic content and compensatory export requirements.

The welfare costs can be measured as the effects of distortions in the markets for assembled vehicles and components. The cost to consumers of the restric-
tions is area abcd, the reduction in consumer surplus compared with what it would be under free trade. Of this, area bcg is the traditional deadweight loss in consumption from higher assembled auto prices.

The consumer loss abcd can be subdivided into transfers to the government, the assembly industry, and the components manufacturers and deadweight losses from inefficient production in the assembly and components industries. Area nfqd represents an increase in profits to domestic assembly operations from the net effect of the entire protective regime. Area fgq represents a production deadweight loss, the extra cost of assembling \( Q_A - Q_A^{*} \) vehicles within the country rather than buying them in the world market at \( P_A^{*} \). Area hefn is a transfer to the government from tariff revenues on kits.

The compensatory export requirements for kits and the domestic content requirements shift up the assembly industry supply curve from \( S_A \) to \( S_A^{*} \). At the resulting domestic level of assembly operations, \( Q_A \), area abeh represents the extra cost of components to assemblers because of these restrictions. The increased cost to domestic assemblers of area abeh is in part a transfer to domestic manufacturers of components and in part a deadweight efficiency loss. Area abeh in figure 1 equals area ikl in figure 2.\(^9\) Area ijml represents a transfer to the domestic components manufacturers in the form of higher profits. Area jkm represents a deadweight loss—from the excess of domestic production costs over the price at which the components could have been purchased in the world market—for the extra output, mk, produced because of the domestic content requirements and the compensatory export requirements for kits. The net effect, ignoring transfers, is a consumption loss of bcg (in figure 1) and production deadweight losses of fgq (in figure 1) and jkm (in figure 2) in the assembly and components industries, respectively.

The various elements of the protective regime affect domestic assembly operations in different, and potentially contradictory, ways. Higher prices for finished vehicles encourage greater output from domestic assembly operations, whereas the domestic content and compensatory export requirements and the tariff on kits increase input costs and discourage domestic assembly activity. On balance, the effective rate of protection provided to domestic assembly operations could be either positive or negative, depending on the net impact of all the regulations.\(^{10}\)

\(^9\) Area abeh = \( \alpha P_{C}^{*} \left[ \pi \delta + (1 - \delta)\xi_{K} \right] Q_{A} \)

\(^{10}\) The prohibition of imports provides a greater protective effect the greater the domestic demand for vehicles. During the Philippine economic downturn in the early 1980s (which would have decreased domestic demand and decreased the ad valorem equivalent protection to the assembly industry), affiliates of Ford, Isuzu, and Toyota all shut down operations.
Table 3. Losses and Transfers Caused by the Protective Regime in the Motor Vehicle Industry in the Philippines, 1990

<table>
<thead>
<tr>
<th>Loss or transfer and area in figures</th>
<th>Cars Millions of pesos</th>
<th>Cars Percentage of sales</th>
<th>Commercial vehicles Millions of pesos</th>
<th>Commercial vehicles Percentage of sales</th>
<th>Total Millions of pesos</th>
<th>Total Percentage of sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer loss, abcd</td>
<td>3,231</td>
<td>40</td>
<td>1,997</td>
<td>40</td>
<td>5,228</td>
<td>40</td>
</tr>
<tr>
<td>Efficiency loss (consumption), bcg</td>
<td>476</td>
<td>6</td>
<td>294</td>
<td>6</td>
<td>770</td>
<td>6</td>
</tr>
<tr>
<td>Transfer to assembly industry, nfqd</td>
<td>955</td>
<td>12</td>
<td>831</td>
<td>17</td>
<td>1,786</td>
<td>14</td>
</tr>
<tr>
<td>Efficiency loss (assembled autos), fgq</td>
<td>108</td>
<td>1</td>
<td>148</td>
<td>3</td>
<td>256</td>
<td>2</td>
</tr>
<tr>
<td>Transfer to components industry, ijml</td>
<td>831</td>
<td>10</td>
<td>376</td>
<td>8</td>
<td>1,207</td>
<td>16</td>
</tr>
<tr>
<td>Efficiency loss (components), jkm</td>
<td>165</td>
<td>2</td>
<td>60</td>
<td>1</td>
<td>225</td>
<td>2</td>
</tr>
<tr>
<td>Total transfer to producers, nfqd + ijml</td>
<td>1,786</td>
<td>22</td>
<td>1,207</td>
<td>24</td>
<td>2,993</td>
<td>23</td>
</tr>
<tr>
<td>Total efficiency loss, bcg + fgq + jkm</td>
<td>749</td>
<td>9</td>
<td>502</td>
<td>10</td>
<td>1,251</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Author's calculations.
Table 4. Consumer and Efficiency Losses per Unit Assembled Caused by the Protective Regime, 1990

<table>
<thead>
<tr>
<th>Loss</th>
<th>Cars</th>
<th>Commercial vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer loss per unit assembled</td>
<td>93,840</td>
<td>90,506</td>
</tr>
<tr>
<td>Efficiency loss per unit assembled</td>
<td>21,754</td>
<td>22,740</td>
</tr>
</tbody>
</table>

Source: Author's calculations.

IV. APPLICATION OF THE MODEL TO THE PHILIPPINES

The magnitude of the areas in figures 1 and 2 identified above as net welfare losses and transfers from the entire protective regime can be calculated for the Philippines based on the actual values of the policy parameters—the tariff on kits, the compensatory export requirement on kits, and the percentage of components that must be sourced locally—and observed or assumed values of other variables and parameters for the motor vehicle industry. The method used to quantify the magnitude of the losses and transfers is explained in appendix A. Separate calculations were made for the Car Development Program (CDP) and the Commercial Vehicle Development Program (CVDP). Appendix B explains the sources of the data and the values of the variables and parameters used in the calculations.

Tables 3 and 4 present the results of applying the model to the Philippine data. These estimates are rough approximations of the potential magnitudes of the costs, not exact estimates. To my knowledge, no estimate of the elasticity of demand for, or supply of, motor vehicles in the Philippines is available. A value of 1.0 was used for the elasticity of demand, consistent with estimates of the demand elasticity in the United States.11 The value of 1.0 for the elasticity of supply was used as a benchmark. Also, as explained in appendix B, the values of some parameters for cars had to be borrowed from the values for commercial vehicles for lack of data.

The estimated cost of the protective regime to purchasers of motor vehicles in 1990 was about 5.2 billion pesos ($215 million) a year.12 This loss amounts to approximately 40 percent of the value of vehicle sales in the Philippines and is roughly equivalent to $3,800 per vehicle assembled domestically. The assembly industry and the components industry benefited from the protective regime, gaining 1.8 billion pesos ($73 million) and 1.2 billion pesos ($50 million), respectively. The transfer to producers amounted to about 22 percent of sales.

11. Estimates of the elasticity of demand for automobiles in the United States are available from a number of sources. Hess (1977) reports previously estimated demand elasticities by Chow (1960) of 0.6 and 1.0 and by Juster and Wachtel (1972) of 0.9 and 1.1. Hess's model yields a somewhat larger elasticity estimate of 1.63. Suits (1958) reported previous estimates by Roos and von Szeliski (1939) of 1.5 and by Atkinson (1950) of 1.3. Suits's own model yielded estimates of 0.59 and 0.55. Given this range of results, the value of 1.0 appeared a reasonable value for the elasticity of demand for motor vehicles in this study.

12. All dollar amounts are in current U.S. dollars. A billion is 1,000 million.
revenue, with somewhat larger gains for the assemblers than for manufacturers of components. The deadweight efficiency losses exceeded 1.2 billion pesos ($50 million), or about 22,000 pesos ($895) per vehicle. The total efficiency losses corresponded to about 10 percent of the value of sales.

V. ALTERNATIVE LIBERALIZATION SCENARIOS

The calculations in section IV estimate the cost of the entire protective regime, including tariffs, domestic content requirements, and compensatory export requirements. These costs are the gains that could be achieved by moving to completely free trade. Eliminating all of the restrictions overnight might lead to adjustment problems, but these could be limited by gradual liberalization. The major parameters of the system, specifically the percentage of domestic content required, the percentage of compensatory exports required for kits, and the tariff rates on kits, could be lowered in stages according to a preannounced schedule to allow gradual adjustment. The prohibition on imports of assembled vehicles could be replaced by a tariff and phased out gradually. Care would need to be taken during the process of liberalization to avoid inadvertently increasing the degree of effective protection to the assembly industry by, for example, phasing out tariffs on kits, domestic content requirements, and compensatory export requirements faster than the tariff on finished vehicles. Doing so would temporarily increase the costs of protection and provide false signals to the domestic industry by temporarily further encouraging domestic assembly operations.
An alternative liberalization scenario would be to eliminate the quantitative restrictions in the current regime (the prohibition on imports of new assembled vehicles, and the domestic content and compensatory export requirements) but to maintain the existing tariff rates for assembled vehicles and kits.\(^\text{13}\) The welfare impact of eliminating the domestic content and compensatory export restrictions can be assessed by calculating the size of the transfers and net costs under a tariffs-only regime and comparing the results with those calculated in section IV for the entire existing protective regime.

Eliminating the embargo on imports of assembled vehicles would allow unlimited importation of vehicles at the current tariff rate. The price of vehicles to consumers would fall to the import price plus the tariff paid, or \(P_A(1 + t_A)\), where \(t_A\) is the ad valorem tariff on assembled vehicles. The market for assembled vehicles under the tariffs-only regime is illustrated in figure 3. At the tariff rate \(t_A\), the domestic vehicle price would be \(P_A(1 + t_A)\). \(D_A\) vehicles would be sold, of which \(Q_A^*\) would be assembled within the country and \((D_A - Q_A^*)\) would be imported. The consumer surplus loss attributable to the tariff on assembled vehicles would be area \(rsd\), of which \(sgc\) would be a deadweight consumption loss.

On the production side, if the domestic content and compensatory export requirements were abolished, assembly firms would be free to import components at the world price, so the price of components would fall to \(P_{c}(1 + t_K)\) (figure 4). Production of components would fall to \(Q_{c}^*\). The lower components cost would reduce assembly industry costs and shift the supply curve down (from the equivalent of \(S_A\) in figure 1) to \(S_{c}^*\) (figure 3). \(S_{c}^*\) lies above \(S_A\) by the

\(^\text{13}\) Although it may seem odd to have a tariff on imports when imports are prohibited, there are some exceptions to the prohibition (such as imports by diplomats and occasional special exemptions for buses).
Table 5. Impact of Removing Domestic Content and Export Requirements at Prevailing Tariff Rates in the Motor Vehicle Industry in the Philippines, 1990

<table>
<thead>
<tr>
<th>Loss or transfer and area in figures</th>
<th>Millions of pesos</th>
<th>Percentage change</th>
<th>Millions of pesos</th>
<th>Percentage change</th>
<th>Millions of pesos</th>
<th>Percentage change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer loss, rsdc</td>
<td>-142</td>
<td>-4</td>
<td>-221</td>
<td>-11</td>
<td>-363</td>
<td>-7</td>
</tr>
<tr>
<td>Efficiency loss (consumption), scg</td>
<td>-48</td>
<td>-10</td>
<td>-70</td>
<td>-23</td>
<td>-118</td>
<td>-15</td>
</tr>
<tr>
<td>Transfer to assembly industry, wuqd</td>
<td>+367</td>
<td>+38</td>
<td>-16</td>
<td>-2</td>
<td>+383</td>
<td>+21</td>
</tr>
<tr>
<td>Efficiency loss (assembly), uvq</td>
<td>+94</td>
<td>+87</td>
<td>+6</td>
<td>+4</td>
<td>+100</td>
<td>+39</td>
</tr>
<tr>
<td>Transfer to components industry, xyml</td>
<td>-367</td>
<td>-44</td>
<td>-191</td>
<td>-51</td>
<td>-578</td>
<td>-48</td>
</tr>
<tr>
<td>Efficiency loss (components), yzm</td>
<td>-104</td>
<td>-63</td>
<td>-43</td>
<td>-71</td>
<td>-147</td>
<td>-65</td>
</tr>
<tr>
<td>Total transfer to producers, wuqd + xyml</td>
<td>+1</td>
<td>0</td>
<td>-175</td>
<td>-14</td>
<td>-174</td>
<td>-6</td>
</tr>
<tr>
<td>Total efficiency loss, scg + uvq + yzm</td>
<td>-58</td>
<td>-8</td>
<td>-107</td>
<td>-21</td>
<td>-165</td>
<td>-13</td>
</tr>
<tr>
<td>Tariff revenue gain</td>
<td>1,136</td>
<td>n.a.</td>
<td>552</td>
<td>n.a.</td>
<td>1,688</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

n.a. Not applicable.

Source: Author's calculations.
Table 6. Consumer and Efficiency Losses per Unit Assembled Caused by Removing Domestic Content and Export Requirements at Prevailing Tariff Rates, 1990

<table>
<thead>
<tr>
<th>Loss</th>
<th>Cars</th>
<th>Commercial vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pesos</td>
<td>Percentage change from protective regime</td>
</tr>
<tr>
<td>Consumer loss per unit assembled</td>
<td>-4,124</td>
<td>-4</td>
</tr>
<tr>
<td>Efficiency loss per unit assembled</td>
<td>-1,685</td>
<td>-8</td>
</tr>
</tbody>
</table>

Source: Author’s calculations.

extra cost of components per vehicle caused by the tariff, $aP^c_k$. At the prevailing price for assembled vehicles under the tariff structure, $P_A(1 + t_A)$, the domestic industry would assemble $Q_A$ vehicles.

In the assembly industry, the deadweight loss from domestic production at costs above the world market price under the tariff regime would be area $uvq$ (in figure 3). Area $wuqd$ represents extra profits in the assembly industry above those it would earn under free trade. This represents a transfer from consumers to assembly firms. In the components industry, the deadweight loss under the tariffs-only regime would be $yzm$ (in figure 4), and the transfer to components manufacturers would be $xym$.

The changes in the transfers and costs of protection that would result from switching to a tariffs-only regime appear in tables 5 and 6. The method of calculating these figures is also explained in appendix A. Eliminating the domestic content and compensatory export requirements while maintaining current tariff rates would benefit purchasers of vehicles. The consumer loss would drop by 4 percent for cars and 11 percent for commercial vehicles. The decrease is not very dramatic, because the existing tariff rate is fairly high (50 percent on cars and an average 46 percent on commercial vehicles).

The switch to a tariffs-only regime at current rates would greatly benefit the assembly industry. The significant drop in the cost of components would increase the effective rate of protection to assembly operations, boost the transfers to the assembly firms by about 21 percent, and increase the efficiency losses from assembly operations by about 39 percent. In contrast, the transfers to the components industry would be cut almost in half, and the efficiency losses from domestic production of components would fall by 65 percent. This result implies that an elimination of the domestic content and compensatory export requirements should be accompanied by a tariff cut on assembled vehicles to increase the gains to purchasers of vehicles and prevent an increase in the effective rate of protection to assembly operations.

VI. CONCLUSIONS AND POLICY RECOMMENDATIONS

The motor vehicle industry in the Philippines is protected by a complicated set of regulations consisting of a virtual prohibition on imports of assembled vehi-
cles, tariffs on imported components and assembled vehicles, domestic content requirements, and compensatory export requirements. This protective regime keeps vehicle prices high, maintains high-cost domestic production of both vehicles and components, and transfers large sums to special interest groups.

Purchasers of motor vehicles are hurt by the high vehicle prices. Assembly operations are encouraged by these high prices but discouraged by higher input costs resulting from the tariff on imported components and from the domestic content and compensatory export requirements. On balance, the entire protective regime could result in either a positive or negative effective rate of protection to vehicle assemblers. Evidence indicates that the 1990 Philippine protective regime provided a positive effective rate of protection.

Domestic producers of components are unambiguously helped by all of the elements of the protective regime. The tariff on kits protects them from imported components, the import restriction on assembled vehicles helps maintain domestic assembly operations and the domestic demand for components, the domestic content requirements force domestic assembly operations to use domestically produced components, and the compensatory export requirements for importing kits increase the demand for domestically produced components for export. The compensatory export requirements in fact act like an export subsidy to the components industry. All the elements of the protective regime increase the demand for components produced within the country and drive up both price and output in the market for domestic components.

Estimates indicate that the protective regime imposes substantial costs on consumers and encourages the allocation of resources to relatively high-cost activities. Eliminating the domestic content and compensatory export requirements at 1991 tariff rates would benefit consumers but would boost the effective rate of protection to assembly operations because of the substantial decrease in the cost of components. To avoid increasing the effective rate of protection to assembly operations during the liberalization, elimination of the domestic content and compensatory export requirements would need to be accompanied by decreases in the tariff rates on assembled vehicles.

APPENDIX A. QUANTIFYING THE WELFARE LOSSES AND TRANSFERS UNDER THE PROTECTIVE REGIME

The magnitude of the areas in figures 1 and 2 that represent the transfers and losses resulting from the protective regime can be estimated for the Philippines based on the actual values of the policy parameters—the tariff on kits, the compensatory export requirement on kits, and the percentage of components that must be sourced locally—and observed values of other variables for the motor vehicle industry. The calculations of welfare losses and transfers are based on a model (as illustrated in figures 1 and 2) with linear demand and supply curves, with the assumed elasticities at the initial protected equilibrium.

The consumer loss was identified as area abcd in figure 1. Let \( \phi = (P_A - P_A^*)/P_A^* \) be the percentage by which the price of domestically assembled vehicles...
exceeds the price of equivalent foreign vehicles, and $\eta_{DA}$ be the elasticity of demand for assembled vehicles. Then,

\[
\text{Area abcd} = (P_A - P_A^*) Q_A + \frac{1}{2} (P_A - P_A^*)(D_A^* - Q_A)
\]

\[
= \phi P_A Q_A + \frac{1}{2} \phi P_A^* (dQ_A/dP_A)(P_A/Q_A)(Q_A/P_A) P_A^* \phi
\]

\[
= \frac{\phi}{(1 + \phi)} P_A Q_A + \frac{1}{2} \left[ \frac{\phi}{(1 + \phi)} \right] P_A Q_A \eta_{DA} [\phi/(1 + \phi)]
\]

\[
(A-1)
\]

\[
= \frac{\phi}{(1 + \phi)} V_A \left[ 1 + \frac{1}{2} \eta_{DA} [\phi/(1 + \phi)] \right]
\]

where $V_A$ is the value of domestic output of motor vehicles. The deadweight loss in consumption, area bcg, would be

\[
\text{Area bcg} = \frac{1}{2} (P_A - P_A^*)(D_A^* - Q_A)
\]

\[
= \frac{1}{2} \phi P_A [1/(1 + \phi)] Q_A \eta_{DA} [\phi/(1 + \phi)]
\]

\[
= \frac{1}{2} \left[ \frac{\phi}{(1 + \phi)} \right]^2 V_A \eta_{DA} \phi.
\]

The gain to the assembly industry (area nfqd) and the deadweight loss to the economy from excess assembly operations (area fgq) can be calculated by first noting that the height of each of these areas equals the net impact of the restrictive regime, that is, the amount, net of cost increases, by which revenue per vehicle assembled exceeds free-trade revenue per unit. Let this distance (fg) be designated $N$:

\[
N = (P_A - P_A^*) - \alpha P_C^* (1 - \delta) t_K - \alpha P_C^* [\delta \pi + (1 - \delta) x_K \pi].
\]

Let $\sigma = \alpha P_C^*/P_A^*$ be the share of components production in the final cost of a finished vehicle. Then

\[
N = P_A [1/(1 + \phi)] [\phi - \sigma(1 - \delta) t_K + (1 - \delta) x_K \pi].
\]

Let $V^* = (1 - \sigma) P_A^*$ be value added per unit under free trade, let $\epsilon_{SA}$ be the elasticity of the supply of assembled vehicles with respect to value added, and note that $Q_A - Q_A^* = \epsilon_{SA} (Q_A/V) N$. Then,

\[
\text{Area fgq} = \frac{1}{2} N (Q_A - Q_A^*) = \frac{1}{2} N^2 \epsilon_{SA} (Q_A/P_A^*)
\]

\[
(A-2)
\]

\[
= \frac{1}{2} N^2 \epsilon_{SA} Q_A (1 + \phi)/P_A.
\]
The gain to the assembly industry, area nfqd, can be calculated as area nfqd less area fgq, or

\[(A-3) \quad \text{Area nfqd} = Q_A N - \frac{1}{2} N^2 \epsilon_{SA} Q_A (1 + \phi) / P_A.\]

Let \(\epsilon_{SC}\) be the elasticity of supply of components and \(V_C\) be the value of domestic production of components. The deadweight loss from excess production in the components industry is shown in figure 2 as area jkm:

\[
\text{Area jkm} = \frac{1}{2} (P_C - P_C^e)(\Omega_C - \Omega_C^e) \\
= \frac{1}{2} \pi P_C^e \epsilon_{SC} (\Omega_C / P_C) P_C \pi / (1 + \pi) \\
= \frac{1}{2} V_C \epsilon_{SC} [\pi / (1 + \pi)]^2. \quad (A-4)
\]

The transfer to the domestic components industry as a result of the protective regime is area ijml, which equals area ijkl less the deadweight loss:

\[
\text{Area ijml} = (P_C - P_C^e) Q_C - \frac{1}{2} V_C \epsilon_{SC} [\pi / (1 + \pi)]^2 \\
= [\pi / (1 + \pi)] V_C - \frac{1}{2} V_C \epsilon_{SC} [\pi / (1 + \pi)]^2. \quad (A-5)
\]

Equations A-1 through A-5 were used to calculate the estimated costs and transfers associated with the protective regime for motor vehicles in the Philippines. Separate calculations were made for the \(\text{CDP}\) and the \(\text{CVDP}\). The values of the variables and parameters used in the calculations are shown in table A-1. A detailed explanation of the sources of the data used can be found in appendix B.

The impact of eliminating the domestic content and compensatory export requirements at current tariff rates can be assessed by calculating the transfers and costs that would result from a tariffs-only regime at current tariff levels and comparing these with the transfers and costs of the current protective regime. The transfers and losses from the tariff can be quantified using procedures similar to those above for the current protective regime.

Referring to figure 3, the consumer loss can be calculated as

\[
\text{Area rscd} = P_A t_A D_A^N + \frac{1}{2} P_A^e t_A (D_A^e - D_A^N) \\
= P_A t_A [Q_A + \eta_{DA} Q_A [\phi - t_A] / (1 + \phi)] \\
+ \frac{1}{2} P_A^e t_A \eta_{DA} Q_A t_A [1 / (1 + \phi)] \\
= V_A [t_A / (1 + \phi)] [1 + \eta_{DA} (\phi - t_A) / (1 + \phi)] \\
+ \frac{1}{2} V_A \eta_{DA} [t_A / (1 + \phi)]^2. \quad (A-6)
\]

Of this, the deadweight loss in consumption would be
Table A-1. Values of Variables Used to Calculate the Impact of the Protective Regime for Motor Vehicles in the Philippines

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cars</th>
<th>Commercial vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage by which domestic vehicle prices exceed world market prices, $\phi$</td>
<td>0.527</td>
<td>0.527</td>
</tr>
<tr>
<td>Percentage by which domestic components prices exceed world market prices, $\pi$</td>
<td>0.495</td>
<td>0.386</td>
</tr>
<tr>
<td>Tariff on assembled vehicles, $t_A$</td>
<td>0.50</td>
<td>0.46</td>
</tr>
<tr>
<td>Tariff on kits, $t_K$</td>
<td>0.30</td>
<td>0.205</td>
</tr>
<tr>
<td>Percentage of components that must be sourced locally, $\delta$</td>
<td>0.40</td>
<td>0.415</td>
</tr>
<tr>
<td>Compensatory export requirement for kits, $x_K$</td>
<td>0.20</td>
<td>0.10</td>
</tr>
<tr>
<td>Ratio of components cost to final cost of vehicle, $\sigma$</td>
<td>0.740</td>
<td>0.740</td>
</tr>
<tr>
<td>Value of vehicle production (millions of pesos), $V_A$</td>
<td>7,985</td>
<td>4,937</td>
</tr>
<tr>
<td>Quantity of vehicles assembled (units), $Q_A$</td>
<td>34,431</td>
<td>22,076</td>
</tr>
<tr>
<td>Price of assembled vehicle (pesos), $P_A$</td>
<td>231,913</td>
<td>223,636</td>
</tr>
<tr>
<td>Value of components production (millions of pesos), $V_C$</td>
<td>3,008</td>
<td>1,570</td>
</tr>
</tbody>
</table>

(A-7) \[
\text{Area scg} = \frac{1}{2} V_A \eta_D A \frac{t_A}{(1 + \phi)}^2.
\]

To calculate the transfers and costs associated with assembly operations under the tariff regime, denote distance $uv$ as $M$, where

\[
M = P_A^t A - \alpha P_C^t K = \frac{P_A}{(1 + \phi)}(t_A - \sigma t_K).
\]

Then area $uvq = \frac{1}{2} M (Q_A^T - Q_A^*)$

\[
= \frac{1}{2} \left[ \frac{P_A}{(1 + \phi)}(t_A - \sigma t_K) \varepsilon_{SA} Q_A (t_A - \sigma t_K) \right]
\]

(A-8) \[
= \frac{1}{2} \varepsilon_{SA} V_A \left[ \frac{1}{(1 + \phi)}(t_A - \sigma t_K)^2 \right].
\]

The transfer to the assembly industry under the tariff-only regime would be area $wuqd$:

\[
\text{Area wuqd} = M Q_A^T - \text{Area uvq}
\]

\[
= M \left[ Q_A - \varepsilon_{SA} Q_A / P_A (N - M) \right] - \text{Area uvq}.
\]

Given that $(N - M) = P_A \left[ 1/(1 + \phi) \right] (t_A - \sigma t_K) [\phi - \sigma [\pi \delta + (1 - \delta) x_K \pi - \delta t_K] - t_A]$,

(A-9) \[
\text{Area wuqd} = V_A \left[ \frac{1}{(1 + \phi)}(t_A - \sigma t_K) \right] \left[ 1 - \varepsilon_{SA} (\phi - \sigma [\pi \delta + (1 - \delta) x_K \pi - \delta t_K] - t_A) \right]
\]

\[
- \frac{1}{2} \varepsilon_{SA} V_A \left[ \frac{1}{(1 + \phi)}(t_A - \sigma t_K)^2 \right].
\]

The transfer to the components producers, area $xyml$ in figure 4, and the deadweight efficiency loss from extra components production, $yzm$, can be calculated as
Area\ yzm = \frac{1}{2} P^*Ct_K(Q^C - Q^C_0)
(A-10)
= \frac{1}{2} \epsilon_{SC} V_C [t_K/(1 + \pi)]^2.

And Area\ xyml = Area\ xyzl - Area\ yzm
= P^*Ct_KQ^C - \frac{1}{2} \epsilon_{SC} V_C [t_K/(1 + \pi)]^2
(A-11)
= V_C[t_K/(1 + \pi)] [1 + \epsilon_{SC}(t_K - \pi)/(1 + \pi)]
- \frac{1}{2} \epsilon_{SC} V_C(t_K/(1 + \pi))^2.

The tariff revenue collected under the current protective regime, T_0 (from kit imports only), and under the tariff regime, T_1 (from imports of both kits and assembled vehicles) can also be estimated (referring to areas in figure 3):

\begin{align*}
T_0 &= \alpha P^C(1 - \delta)t_K = \sigma(1 - \delta)t_KP_A/(1 + \phi) \\
T_1 &= Area\ rscd - Area\ scg - Area\ uvq - Area\ wuqd - \alpha P^Ct_K \\
(A-13) &= Area\ rscd - Area\ scg - Area\ uvq - Area\ wuqd - \sigma t_KP_A/(1 + \phi).
\end{align*}

Appendix B. Values of the Variables and Parameters and Data Sources

Calculation of costs and transfers caused by the protective regime for the motor vehicle industry in the Philippines requires information on prices, production, price differentials between domestic and world prices, and tariff rates as well as some information on costs. Not all of this information is readily available. This appendix explains the sources used, the rationale for the specific values used when alternative estimates were available, and the assumptions used when it was necessary to assume values for particular parameters. The base year of comparison is 1990.

Table A-1 lists the values of variables used to calculate the impact of the protective regime for motor vehicles. The rest of the appendix explains each variable and provides information on the sources for the data.

\begin{itemize}
\item $\phi$ The percentage by which domestic vehicle prices exceed world market prices for equivalent models. The nominal rate of protection associated with quota restrictions on trucks and buses is calculated at 52.7 percent by the Center for Research and Communication (1991: 139, tab. A). Without specific equivalent information for passenger vehicles, the same value was used for passenger vehicles.
\item $\pi$ The percentage by which domestic components prices exceed world market components prices under the protective regime. There are no data currently available on this measure. The regulations specify that domestic components will not exceed the landed cost of imported
components by more than 15 percent. Presuming that the landed cost includes import duties paid and given the tariff rates for kits for passenger vehicles and commercial vehicles, this regulation would imply that the cost of domestic components cannot exceed the cost of imported components by more than 38.6 percent for commercial vehicles or 49.5 percent for passenger vehicles. For the purposes of the estimates in this article, pending more accurate estimates, $\pi$ is set equal to these numbers.

$t_A$ Tariff on assembled vehicles. As of 1991, the tariff rates on assembled vehicles were: passenger cars, 50; jeeps, 50; trucks, 30; and buses, 20 (World Bank data). For commercial vehicles the figure used was 46, the weighted average across jeeps, trucks, and buses, using 1990 sales (Center for Research and Communication 1991, tab. 3.6) as weights.

$t_K$ Tariff on kits. In 1990, the tariff rates on kit imports for motor vehicle assembly were: passenger cars, 30 (1991); Asian utility vehicles, 20; trucks, 20; and buses, 30 (for trucks, buses, and Asian utility vehicles, Center for Research and Communication 1991, tab. 4.10; for passenger cars, World Bank data). Production values from 1990 (Center for Research and Communication 1991, tab. 3.6) were used as weights in the aggregation to estimate the weighted average tariff on commercial vehicles. The resulting average tariff for commercial vehicles was 20.54.

$\delta$ The percentage of components that must be sourced locally. In 1990 the CDP required local content of 40 percent. The local content requirements for commercial vehicles varied by category, as shown in table 1. A weighted average of the local content requirements by category, weighted by 1990 production by category, was calculated using data on output by type of vehicle (Center for Research and Communication 1991, tab. 3.6). The resulting average $\delta$ was 41.5 percent.

$x_K$ Compensatory export requirement for kits. The compensatory export requirement for imports of kits to assemble passenger vehicles is 50 percent. The requirement that exports be automotive products is being phased in. In 1990, 40 percent of the compensatory exports had to be auto industry products. Thus the effective requirement for exports of auto industry products was 20 percent. The compensatory export requirement for imports of kits to assemble commercial vehicles is 25 percent. The phase-in of the requirement that exports be auto industry products reached 40 percent in 1990, which implies an effective compensatory export requirement of auto industry parts of 10 percent.

$\sigma$ Ratio of the cost of components to the final cost of a vehicle. For commercial vehicles, the value was set at 0.74, calculated as a weighted average (weighted by production) of the ratio for trucks (0.743) and buses (0.690). In the absence of specific information for passenger vehicles, the same value was used. The figures for trucks and buses
were calculated from data on CKD kits and local components as a percentage of ex-factory prices from the Center for Research and Communication (1991: 10).

\( V_A \) Value of the production of vehicles. From the Board of Investments (1991, ann. B), prices are unit values calculated from the value and quantity data.

\( Q_A \) Quantity of vehicles assembled. Data are from the Board of Investments (1991, ann. B).

\( P_A \) Price of an assembled vehicle. Data are the for the average price of a vehicle as calculated from value and quantity data in Board of Investments (1991, ann. B).

\( V_C \) Value of the production of components. The value of the production of components is 2,452 million pesos under the CDP and 1,047 million pesos under the CVDP for 1990. These values were estimated as the sum of the purchases of local parts and components by assembly firms—1,596 million pesos under the CDP and 697 million pesos under the CVDP in 1990 (Board of Investments 1991, ann. B, tab. 10)—and the portion of estimated compensatory exports—88 million dollars under the CDP and 36 million dollars under the CVDP in 1990 (Board of Investments 1991, ann. B, tab. 6)—made up of auto industry products (40 percent for both the CDP and the CVDP), converted at the 1990 average exchange rate of 24.311 pesos to one U.S. dollar (International Monetary Fund 1993). The value of components production does not include the manufacture of replacement parts.

\( \eta_{DA} \) Elasticity of demand for assembled motor vehicles. The elasticity is assumed to be equal to 1.

\( \varepsilon_{SA} \) Elasticity of supply of value added in motor vehicle assembly. The elasticity is assumed to be equal to 1.

\( \varepsilon_{SC} \) Elasticity of supply of components industry. The elasticity is assumed to be equal to 1.

**References**

The word "processed" describes informally reproduced works that may not be commonly available through library systems.


World Debt Tables 1993-94
External Finance for Developing Countries

This new edition of the World Bank's annual reference guide provides complete and up-to-date information on the debt of developing countries, including key data on the former Soviet Union.

Volume I analyzes recent developments in international finance for developing countries and summarizes statistical tables for selected regional and analytical groups. Volume II provides statistical tables for 148 countries, including Eastern Europe and the countries of the former Soviet Union.

Volume I Analysis and Summary Tables

Volume II Country Tables

Volume I & II
ISBN 0-8213-2569-8 / US$125.00 / Order Stock #12569

Extracts

Also Available
World Debt Tables 1993-94 — Data on Diskette
ISBN 0-8213-2431-4 / US$95.00 / Order Stock #12431

To order World Debt Tables 1993-94 please use the coupon that follows.
This new edition of the World Bank's most popular collection of data has been revised and expanded. It includes information on more topics than ever before, arranged in an easy-to-use format.

The 26th edition, following the format introduced last year, organizes the statistics under three development themes: The People, The Economy, and The Environment. Introductory texts explain the role each plays in world development. Key social and economic data for 207 economies — including the countries of the former Soviet Union — are listed.

Social data are provided on fertility, illiteracy, population growth, child mortality and more. Economic data include gross national product (GNP) and shares of exports, agriculture, and investment in gross domestic product (GDP). In the section on the environment, data are presented on deforestation, water use, energy consumption, and land use, as well as oil consumption.

Text appears in English, French, and Spanish. Easy-to-read world maps, tables, and graphs make this an ideal reference for office or classroom.

World Bank Atlas 1994

To order the World Bank Atlas 1994 please use the coupon that follows.
The startling economic success of eight East Asian countries and the reasons for it are examined in this new series. This report looks at the public policies of these high-performing Asian economies (HPAEs) from 1965 to 1990. It seeks to discover the role those policies played in dramatic economic growth, improved human welfare, and more equitable income distribution in Hong Kong, Indonesia, Japan, Malaysia, the Republic of Korea, Singapore, Taiwan (China), and Thailand.

This study looks at how a focus on sound development policies to stabilize their economies led to fast growth. HPAEs were also committed to sharing the new prosperity by making income distribution more equitable.

In presenting the lessons developing countries can learn from East Asia's approach to rapid growth, this report reviews the basic development policies that created macroeconomic stability. It explains why most countries should not use government interventions in today's changing global economy.

Published for the World Bank by Oxford University Press

Also available
The East Asian Miracle: Summary
Developing the Occupied Territories
An Investment in Peace

This series of six reports examines the development needs of the West Bank and Gaza Strip. It provides a comprehensive 10-year economic plan for the transition period expected under the peace agreement. The plan recommends policy reforms for the macroeconomy and the infrastructure, as well as for agriculture, social services, and private sector development.

Volume I summarizes the key findings and recommendations in the series. Volume II looks at the different approaches to managing the macroeconomy efficiently. Volume III, on the program for developing private enterprise, looks at ways to modernize the financial system and make the legal framework more transparent and equitable. Volume IV examines why future agricultural growth will be limited to high-value export crops for specialized markets. Development strategies for key infrastructure services are presented in Volume V. Finally, Volume VI describes the need to make social services more equitable.

Volume I: Overview
40 pages / ISBN 0-8213-2688-0 / $6.95 / Order Stock #12688
Volume II: The Economy
Volume III: Private Sector Development
Volume IV: Agriculture
110 pages / ISBN 0-8213-2691-0 / $7.95 / Order Stock #12691
Volume V: Infrastructure
124 pages / ISBN 0-8213-2692-9 / $7.95 / Order Stock #12692
Volume VI: Human Resources and Social Policy
82 pages / ISBN 0-8213-2693-7 / $6.95 / Order Stock #12693

To order Developing the Occupied Territories please use the coupon that follows.
CUSTOMERS IN THE UNITED STATES: Complete this coupon and return to
The World Bank
Box 7247-8619
Philadelphia, PA 19170-8619
U.S.A.
To have your order shipped faster, charge
by credit card by calling (202) 473-1155
or send this completed order coupon by facsimile
by dialing (202) 676-0581.

CUSTOMERS OUTSIDE THE UNITED STATES:
Contact your local World Bank Publications
distributor for information on prices in local
currency and payment terms. (For a complete
list of distributors, see back.) If no distributor
is listed for your country, use this order form
and return it to the U.S. address. Orders that
are sent to the U.S. address from countries
with distributors will be returned to the
customer.

<table>
<thead>
<tr>
<th>Title</th>
<th>Stock Number</th>
<th>Price</th>
<th>Qty.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal US$ __________
Shipping and Handling* US$ __________
Total US$ __________

* SHIPING AND HANDLING charges are $5.00 per order. If a purchase order is used, actual
shipping will be charged. For air mail delivery outside North America, add $8.00 for one item
plus $6.00 for each additional item.

CHECK METHOD OF PAYMENT

☐ Enclosed is my check payable to The World Bank.

☐ Charge my ☐ VISA ☐ MasterCard ☐ American Express

Credit card account number

Expiration Date __________ Signature __________

☐ Bill me. (Institutional customers only. Purchase order must be included.)

PLEASE PRINT CLEARLY

Name ____________________________________________

Address ____________________________________________

City __________________________ State __________ Postal Code __________

Country __________________________ Telephone __________
## Distributors of World Bank Publications

**Prices and terms vary by country**

### Argentina
- Carlos Hirsch, SRL
- Galeria Guernos
- Florida 165, 4th Floor-Ofc. 453/465
- 1333 Buenos Aires

### Australia
- Papua New Guinea
- Fiji, Solomon Islands
- Vanuatu, and Western Samoa

### Belgium
- Jean De Lannoy
- Av. du Roi 202
- 1060 Brussels

### Canada
- Le Diffuseur
- 151A Boul. de Montagne
- Boucherville, Quebec
- J4B 5G6

### Chile
- Inversion ITG S.A.
- Av. Santa Maria 6400
- Edificio INTUC, Of. 201
- Santiago

### China
- China Financial & Economic Publishing House
- 8, Da Fe Si Dong Jie
- Beijing

### Colombia
- Infoentice Ltda.
- Apartado Aereo 34270
- Bogota D.E.

### Cote d'Ivoire
- Centre d'Edition et de Diffusion Africaines (CEDA)
- 04 B.P. 541
- Abidjan 04 Plateau

### Cyprus
- Center of Applied Research
- Cyprus College
- 6, Diogenes Street, Engomi
- P.O. Box 2006
- Nicosia

### Denmark
- Samfundslitteratur
- Rosenørns Allé 11
- DK-1970 Frederiksberg C

### Dominican Republic
- Ediciones Taller, C.p.r.
- Restauración e Isabel la Católica 309
- Apartado de Correos 2190 Z-1
- Santo Domingo

### Egypt, Arab Republic of
- Al Ahram
- Al Galaa Street
- Cairo

### Eritrea, Arab Republic of
- Al Alhron
- Al Galaa Street
- Cairo

### Finland
- Alateeminen Kirjakauppa
- P.O. Box 128
- SF-00101 Helsinki 10

### France
- World Bank Publications
- 66, avenue d'Iéna
- 75116 Paris

### Germany
- UNO-Verlag
- Poppenbüderstrale 55
- D-3300 Bonn 1

### Hong Kong, Macao
- Asia 2000 Ltd.
- 64-65 Wyndham Street
- Winning Centre

### Hungary
- Foundation for Market Economy
- Dombovari Ut 17-19
- H-1117 Budapest

(continued on reverse)
<table>
<thead>
<tr>
<th>Country</th>
<th>Address/Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAPAN</td>
<td>Eastern Book Service&lt;br&gt;Hongo 3-Chome, Bunkyo-ku 113&lt;br&gt;Tokyo</td>
</tr>
<tr>
<td>KENYA</td>
<td>Africa Book Service (E.A.) Ltd.&lt;br&gt;Quaran House, Mwangambo Street&lt;br&gt;P.O. Box 45245&lt;br&gt;Nairobi</td>
</tr>
<tr>
<td>KOREA, REPUBLIC OF</td>
<td>Pan Korea Book Corporation&lt;br&gt;P.O. Box 101, Kwangwhamun&lt;br&gt;Seoul</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>University of Malaya Cooperative Bookshop, Limited&lt;br&gt;P.O. Box 1127, Jalan Pantai Baru&lt;br&gt;59700 Kuala Lumpur</td>
</tr>
<tr>
<td>MEXICO</td>
<td>INFOTEC&lt;br&gt;Apartado Postal 22-860&lt;br&gt;1400 Tlalpan, Mexico D.F.</td>
</tr>
<tr>
<td>NETHERLANDS</td>
<td>De Lindeboom/InOr-Publikaties&lt;br&gt;P.O. Box 202&lt;br&gt;7480 AE Haaikbergen</td>
</tr>
<tr>
<td>NEW ZEALAND</td>
<td>EBSO NZ Ltd., Private Mail Bag 99914&lt;br&gt;New Market&lt;br&gt;Auckland</td>
</tr>
<tr>
<td>NIGERIA</td>
<td>University Press Limited&lt;br&gt;Three Crowns Building Jericho&lt;br&gt;Private Mail Bag 5995&lt;br&gt;Badan</td>
</tr>
<tr>
<td>NORWAY</td>
<td>Narvesen Information Center Book Department&lt;br&gt;P.O. Box 6125 Etterstad&lt;br&gt;N-0602 Oslo 6</td>
</tr>
<tr>
<td>PAKISTAN</td>
<td>Mirza Book Agency&lt;br&gt;65, Shahrah-e-Quaid-e-Azam&lt;br&gt;P.O. Box No. 729&lt;br&gt;Lahore 54000</td>
</tr>
<tr>
<td>PERU</td>
<td>Editorial Desarrollo SA&lt;br&gt;Apartado 3824&lt;br&gt;Lima 1</td>
</tr>
<tr>
<td>PHILIPPINES</td>
<td>International Book Center&lt;br&gt;Suite 1703, Cityland 10&lt;br&gt;Condominium Tower 1&lt;br&gt;Ayala Avenue, H.V. dela Costa Extension&lt;br&gt;Makati, Metro Manila</td>
</tr>
<tr>
<td>POLAND</td>
<td>International Publishing Service&lt;br&gt;Ul. Pieka 31/37&lt;br&gt;00-677 Warszawa</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>Livraria Portugal&lt;br&gt;Rua De Carmo 70-74&lt;br&gt;1200 Lisbon</td>
</tr>
<tr>
<td>SAUDI ARABIA, QATAR</td>
<td>Jarir Book Store&lt;br&gt;P.O. Box 31166&lt;br&gt;Riyadh 11471</td>
</tr>
<tr>
<td>SINGAPORE, TAIWAN, MYANMAR, BRUNEI, SINGAPORE, TAIWAN, MYANMAR, BRUNEI, SINGAPORE, TAIWAN, MYANMAR, BRUNEI, SINGAPORE, TAIWAN, MYANMAR, BRUNEI</td>
<td>Gower Asia Pacific Pte Ltd.&lt;br&gt;Golden West Building&lt;br&gt;41, Kallang Pudding, #04-03&lt;br&gt;Singapore 1334</td>
</tr>
<tr>
<td>SOUTH AFRICA, BOTSWANA</td>
<td>For single titles:&lt;br&gt;Oxford University Press&lt;br&gt;Southern Africa&lt;br&gt;P.O. Box 1141&lt;br&gt;Cape Town 8000</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>For single titles: Pritzew Fackboforetaget&lt;br&gt;Regeringsgatan 12, Box 16356&lt;br&gt;S-103 27 Stockholm</td>
</tr>
</tbody>
</table>
Coming in the next issue of

THE WORLD BANK ECONOMIC REVIEW

May 1994
Volume 8, Number 2

Articles on . . .

• Measuring the Restrictiveness of Trade Policy
  by James E. Anderson and J. Peter Neary

• The Trade Restrictiveness of the Multi-Fibre Arrangement
  by James E. Anderson and J. Peter Neary

• Labor Supply and Targeting in Poverty Alleviation Programs
  by Ravi Kanbur, Michael Keen, and Matti Tuomala

• Dual Exchange Rates in Europe and Latin America
  by Nancy P. Marion

• The Impact of Mexico’s Retraining Program on Employment and Wages
  by Ana Revenga, Michelle Riboud, and Hong Tan

• The Distribution of Subsidies through Public Health Services in Indonesia, 1978–87
  by Dominique van de Walle