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## In This Issue . . .

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Trade-remedy laws are intended to lessen the hardship on U.S. firms resulting from the actions and policies of foreign firms and governments. Theoretically, these laws produce a "fair" and "free" trading environment. In practice, however, the concept of fair trade is often used by special-interest groups to pursue their own agenda at the expense of the national interest.

In the first article in this *Review*, "U.S. Trade-Remedy Laws: Do They Facilitate or Hinder Trade?" Cletus C. Coughlin analyzes the primary trade-remedy laws and concludes that their increasing use is hindering free trade. These trade-remedy laws, says the author, are producing a protectionist trading environment, which lowers economic well-being in the United States, rather than a fair and free environment, which would benefit the nation.

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In the second article of this *Review*, "The Behavior of Retail Gasoline Prices: Symmetric Or Not?" Jeffrey D. Karrenbrock examines the behavior of retail gasoline prices. As the author first points out, oil producers and refiners are not the only entities on the supply side who influence gasoline prices. Because retailers also play a role in determining the retail price of gasoline, they could be equally responsible for any price anomalies that occur in the industry—including the popular belief that gasoline prices are increased more and reduced less in response to rises and falls in the underlying price of crude oil.

Karrenbrock's analysis finds little evidence to support this "price-gouging" hypothesis, however. He finds that retail gasoline prices respond symmetrically to wholesale price increases and decreases in both the timing and the amount of price pass-through. Karrenbrock does note that the retail price adjustment lags are shorter for a wholesale price increase than they are for a decrease.

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During the early 1980s, while the Federal Reserve was pursuing an anti-inflationary monetary policy, the U.S. farm sector also experienced one of its worst downturns since the 1920s. Many observers linked the two events, arguing that restrictive monetary policy hurt farm income because it caused farm product prices to decline more quickly than farm input prices; the result was a "cost-price squeeze" that, according to this argument, caused farm income to fall.

In the third article of this issue, "Monetary Policy and the Farm/Non-farm Price Ratio: A Comparison of Effects in Alternative Models," Michael T. Belongia reviews several models that have been used to link monetary policy to the relative price of farm products. The author then



attempts to synthesize the conflicting empirical evidence that has been brought to bear on each. By using consistent measures of prices and monetary actions and estimating each model over the same time period, he finds that monetary actions have weak and short-lived effects on the farm/nonfarm product price ratio.

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In the fourth article in this issue, "The Multiplier Approach to the Money Supply Process: A Precautionary Note," Michelle R. Garfinkel and Daniel L. Thornton show that the money multiplier is not independent of monetary policy actions as is commonly assumed. They note that, for the multiplier to be independent of policy actions, movements in the ratio of currency to checkable deposits (the most important determinant of the multiplier) must be due to individuals simply adjusting their holdings of currency and checkable deposits. Most of the movement in this ratio, however, is due to policy-induced changes in checkable deposits, say the authors; moreover, the influence of policy actions on the multiplier has become more important since the implementation of the Monetary Control Act of 1980. Since then, the relationship between checkable deposits and reserves has become particularly close.

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Reliable information about the amount of production a state ultimately exports is essential for anyone interested in state economic development. Unfortunately, no ideal measure of state export activity exists.

In the final article in this issue, "Measuring State Exports: Is There a Better Way?" Cletus C. Coughlin and Thomas B. Mandelbaum contrast the two currently available state export series. The most prominent deficiency of both is that they are based on the value of export shipments from firms within a state rather than on the value of economic activity related to exports within a state. To address this deficiency, Coughlin and Mandelbaum develop a third measure of state manufactured exports. Comparisons between this and an existing measure of export activity illuminate the shortcomings of the two available series and the advantages of the new series.

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## **Cletus C. Coughlin**

*Cletus C. Coughlin is a research officer at the Federal Reserve Bank of St. Louis. Thomas A. Pollmann provided research assistance. The author acknowledges the valuable suggestions of Seth Kaplan.*

# **U.S. Trade-Remedy Laws: Do They Facilitate or Hinder Free Trade?**

"Our fair trade laws are the bedrock on which free trade stands."  
— Malcolm Baldrige

**A**N INCREASINGLY contentious issue in international trade pertains to so-called "trade-remedy laws." These laws are intended to remedy hardships for U.S. firms resulting from the actions and policies of foreign firms and governments. Allegedly, these laws produce a "fair" and "free" trading environment. The possibility exists, however, that the concept of fair trade is simply a pretext used by interest groups to pursue their own interests at the expense of the national interest. This can result in a protectionist trading environment, which lowers economic well-being in the United States, rather than a fair and free one.

This paper provides an introduction to U.S. trade-remedy laws. As background to understanding the justification and effects of these laws, the concepts of fair trade, free trade and protectionism are described. Next, an overview of the primary laws is provided. This is followed by evidence on the increasing use of trade-remedy laws. Finally, evidence on the adminis-

tration and effects of these laws is examined to assess competing claims that these laws facilitate or hinder free trade.

## **FAIR TRADE, FREE TRADE AND PROTECTIONISM**

To understand the controversy involving trade-remedy laws, one must become familiar with the basic concepts underlying the dispute. The most elusive concept is that of fair trade. On the surface, it is hard to argue against fair trade; however, there are different interpretations of this term and, thus, its application in concrete situations varies across individuals.

Two interpretations of fair trade are related directly to differing impressions of reciprocity, which is a concept of fairness used in international trade negotiations.<sup>1</sup> Before negotiations to reduce trade barriers, two countries will generally have different levels and types of trade bar-

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<sup>1</sup>See Bhagwati and Irwin (1987) for a discussion of fair trade and its relation to U.S. trade policy.



riers. "First-difference" reciprocity means that a fair outcome is characterized by reductions in trade barriers such that the value received by each country stemming from the other country's reduction in trade barriers is equal. Consequently, after the completion of negotiations, the two countries may still retain different patterns of trade barriers.

On the other hand, "full" reciprocity requires that two countries allow identical access to their respective markets, which implies identical trade restrictions. Full reciprocity means that reciprocity of access must be met for individual sectors. This is known as a level playing field.

Negotiations under the auspices of the General Agreement on Tariffs and Trade (GATT) use first-difference reciprocity as a procedural device. Nonetheless, the implicit goal of GATT is to generate a free trade environment, which implies full reciprocity of market access. In such an environment, certain actions, such as government attempts to directly influence the pattern of trade, are viewed as inappropriate and, thus, can be counteracted.<sup>2</sup>

Even though actions taken to open foreign markets and counteract inappropriate behavior by foreign firms and governments can be justified in the name of fair and free trade, these actions might not achieve their stated purpose. If they do not, then the result is higher levels of barriers with adverse consequences.

Trade restrictions tend to reduce the competition faced by domestic producers; this protection is at the expense of domestic consumers. Empirical evidence shows clearly that the losses suffered by consumers exceed the gains reaped by domestic producers and government.<sup>3</sup> Not only are there inefficiencies associated with excessive domestic production and restricted consumption, but there are costs associated with both the enforcement of protectionist legislation and attempts to influence trade policy. Empirical research also shows that the adverse effects of protectionist policies persist because such

policies generate relatively lower growth rates than free trade policies.

## THE BASICS OF TRADE-REMEDY LAWS

The United States employs various trade-remedy laws to provide relief from imports for U.S. industries. These laws are frequently characterized as "contingent protection" because the import relief is provided only under certain conditions.<sup>4</sup> Table 1 lists the principal trade-remedy laws and summarizes their key features.

### *The Escape Clause*

The escape clause, contained in Section 201 of the Trade Act of 1974, allows temporary import barriers when rising imports can be shown to injure a domestic industry seriously.<sup>5</sup> The legislation requires that the increase in imports constitutes "a substantial cause" of serious injury. While a substantial cause is not defined precisely, a working definition is that the cause is important and no less important than any other cause of serious injury.

Two primary justifications exist for escape clauses. The first justification relies on the importance of an "economic adjustment" goal. Rapidly increasing imports can harm selected groups, especially import-competing domestic firms and their workers. Such firms must adjust to rising imports by enhancing productivity or by laying-off employees. Proponents of the escape clause argue that the costs of this adjustment can be reduced if the firm is provided temporary relief from imports.

This argument, however, has some problems. Foremost is that there are numerous circumstances in which firms are forced to make adjustments. Changes in consumer demand, energy price shocks and governmental changes in spending, taxation and regulation necessitate adjustments. If rising imports justify governmental intervention, then it can be argued that these

<sup>2</sup>Bhagwati (1988) characterizes GATT as a "contractarian" institution that regulates inappropriate actions. Political pressures make it difficult to maintain a free trade stance unilaterally, so GATT attempts to prevent those actions that induce others to move away from free trade.

<sup>3</sup>See Coughlin et al. (1988) and Richardson (1989) for recent surveys.

<sup>4</sup>Administered protection and procedural protectionism are two other terms for contingent protection.

<sup>5</sup>Prior to 1974, escape clause legislation required that the rising imports be due to a prior reduction of a trade barrier. The elimination of this necessary relationship by the Trade Act of 1974 appears to make U.S. law inconsistent with GATT. See Jackson (1990) for a comparison of the legal nuances of U.S. law with Article XIX of GATT.



**Table 1**  
**Principal U.S. Trade Law Provisions<sup>1</sup>**

Statute	Focus	Criteria for action	Response	Responsibility
Section 201: Fair Trade (escape clause)	Increasing imports	Increasing imports are substantial cause of injury	Duties, quotas, tariff-rate quotas, orderly marketing arrangements, adjustment assistance	President (ITC recommendation)
Section 301: Unfair Trade	Foreign practices violating a trade agreement or injurious to U.S. trade	Unjustifiable, unreasonable, or discriminatory practices, burdensome to U.S. commerce	All appropriate and feasible action	U.S. trade representative subject to direction by the president
Section 701: Subsidized Imports	Manufacturing, production or export subsidies	Material injury or threat of material injury <sup>2</sup>	Duties	ITC-Injury determination ITA-Subsidy determination
Section 731: Dumped Imports	Imports sold below cost of production or below foreign market price	Material injury or threat of material injury	Duties	ITC-Injury determination ITA-Dumping determination

<sup>1</sup>Origin of current provisions: Tariff Act of 1930 (Smoot-Hawley), as amended; Trade Act of 1974, as amended; Trade Agreements Act of 1979, as amended; Trade and Tariff Act of 1984; Omnibus Trade and Competitiveness Act of 1988.

<sup>2</sup>The material injury test is extended only to countries that fulfill certain conditions.

SOURCE: Council of Economic Advisers (1988, p. 152), modified by author.

other causes of adjustment costs should be mitigated as well. While there are cases other than rising imports that do lead to governmental intervention, where should the line be drawn?

Another facet of the adjustment argument focuses on the fact that rising imports provide benefits to many consumers and impose costs on relatively few firms and workers. An equity argument can therefore be made for shifting some of the burden of adjustment from the few who are harmed to the many who benefit through the tax on consumers imposed by import restrictions.

The second primary justification for escape clauses relates to this argument. A relatively small yet potentially well-organized group harmed

by rising imports could be a formidable force for import restrictions. From a national perspective, it is much better to provide temporary and limited protection for such a group not only to mitigate the burdens of adjustment, but also to reduce the political pressures for more permanent import restrictions. Unfortunately, these temporary measures often become long-lived.<sup>6</sup>

Petitions for relief can be filed by any one of the following groups—individual firms, labor unions, trade associations or selected government bodies (such as the United States Trade Representative, the House Ways and Means Committee and the Senate Finance Committee). The International Trade Commission (ITC) is a six member, appointed body that assesses injury

<sup>6</sup>Lande and VanGrasstek (1986) note that the escape clause allows member countries to impose trade restrictions to mitigate the perceived adverse effects of rising imports, while remaining cognizant of their obligations to

fellow GATT members. This flexibility allows temporary departures from trade obligations without full-fledged repudiations.



after the filing of petitions. Significant declines in sales, production, profits, wages or employment are evidence of serious injury.

Negative ITC decisions require a majority of the commissioners to reject the petition and terminate the process. Affirmative ITC decisions require either a tie or the majority of the commissioners to accept the petition; they are forwarded to the president. A recommendation as to the appropriate trade restriction and/or adjustment assistance to prevent or ameliorate the injury is included. The president, however, is not bound by the ITC's injury finding or its suggested relief. Nevertheless, the Trade Act of 1974 instructs the president to provide relief (which can take the various forms identified in table 1), unless such relief is deemed not to be in the national interest.

### *Unfair Trade Legislation*

The escape clause allows a nation to restrain imports regardless of whether the imports have been assisted by "unfair" practices. Examined below are the three most prominent pieces of U.S. legislation that address the issue of offsetting the effects of unfair actions: 1) Section 701, which deals with governments subsidizing exports; 2) Section 731, which deals with dumping, that is, with foreign firms selling their goods at lower prices in the United States than in their home markets; and 3) Section 301, which deals with violations of trade commitments and a wide range of other actions.

#### *Section 701: Countervailing Duty Legislation*

The legal purpose of countervailing duty legislation is to offset government-provided benefits that assist the exports of foreign firms. These benefits include export subsidies, such as direct government payments, tax relief and subsidized loans to a nation's exporters and low-interest loans to foreign buyers. By inducing additional foreign export activity as U.S. consumers substitute these goods for similar domestically produced goods, these subsidies can injure import-competing U.S. industries. Assuming certain provisions are met, U.S. trade law allows subsidized exports to be counteracted with tariffs termed countervailing duties.

Even if one acknowledges that export subsidies harm a domestic industry, it is possible to question the wisdom of countervailing duties. Many economists argue that if a foreign government subsidizes exports, the importing country should accept the gift of cheaper goods. Resources no longer needed by the import-competing U.S. industries can be employed productively in other sectors of the economy. Countervailing duty legislation, however, focuses on the harm to these import-competing industries and ignores the benefits reaped by consumers and other producers.

Bhagwati (1988), while acknowledging the economic validity of the preceding argument, argues that a free trade regime might depend on unfair trade legislation. Countries pursuing a free trade policy find it difficult to resist the demands for protection when the decline of an industry is due to the market-determined advantages of foreign producers. If the decline is due to the use of export subsidies, demands for protection are heightened because issues of fairness are stressed. A free trade regime that does not counteract artificial advantages might find itself unable to defend and perpetuate its free trade stance.

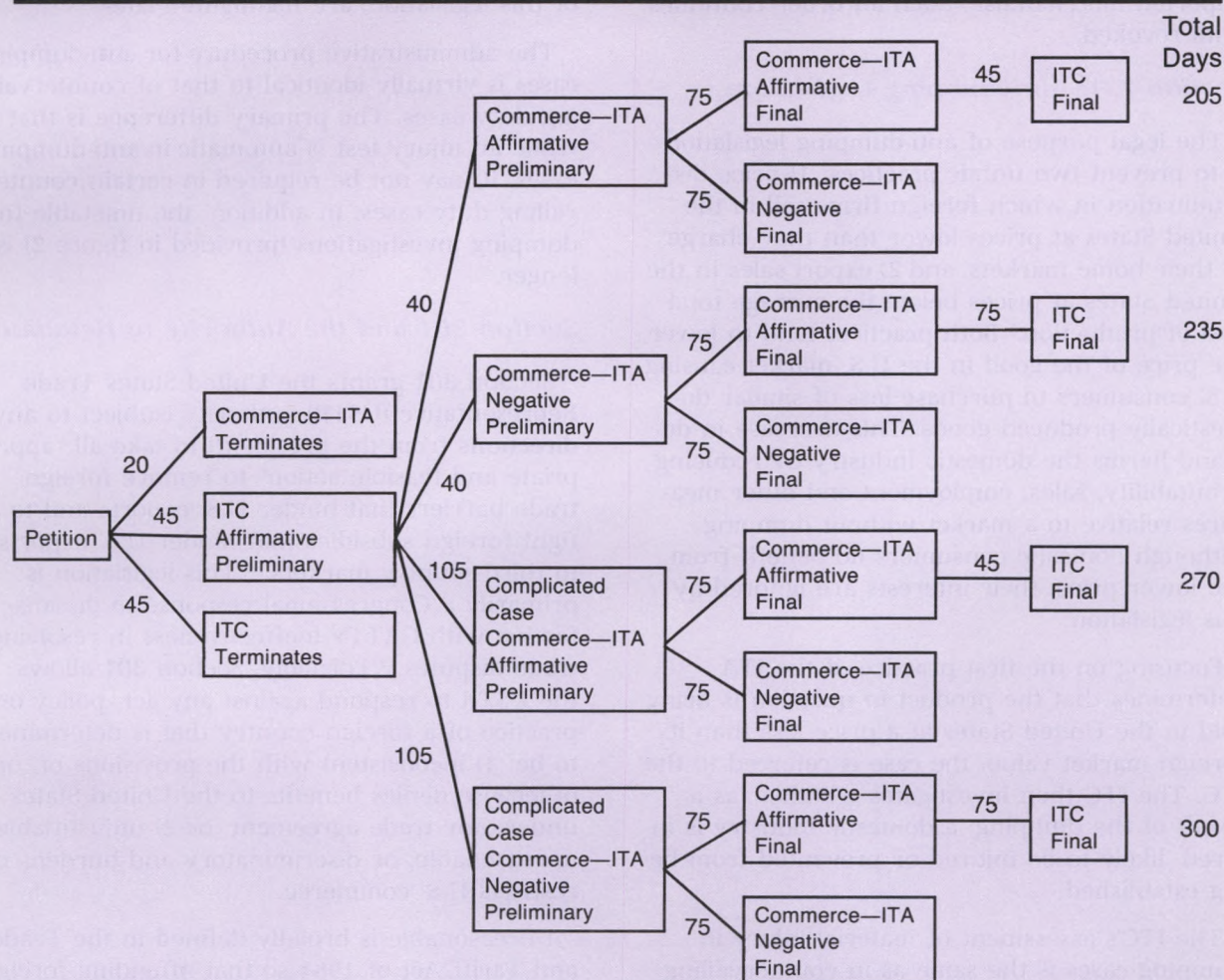
The administration of countervailing duty laws is the joint responsibility of the ITC and the International Trade Administration (ITA) of the Department of Commerce. The ITA determines the existence and magnitude of any subsidy, negotiates agreements to offset any subsidy, imposes duties, reviews the effectiveness of the remedy and determines when the remedy is terminated. Concurrently, the ITC applies an injury test to determine whether subsidized exports have caused or will threaten material injury to a domestic industry or have retarded the establishment of a domestic industry.<sup>7</sup>

Material injury, as defined by the Tariff Act of 1930, is "harm which is not inconsequential, immaterial, or unimportant." While this definition is far from clear, the law does require that the ITC incorporate volume, price and impact considerations in its determination of harm. In examining the volume of imports, the ITC is charged with determining whether an increase in that volume, either absolute or relative to either U.S. consumption or production, is signif-

<sup>7</sup>Lande and VanGrasstek (1986) point out that an injury test is used in countervailing duty cases only when the foreign country meets certain conditions. When an injury test is not required, the ITA has complete control.



Figure 1

**Statutory Timetable for Countervailing Duty Investigations (in days)**

SOURCE: United States International Trade Commission (1987).

icant. With respect to the effect of imports on prices, the ITC looks for significant price undercutting by the imports relative to domestically produced goods and attempts to assess the resulting price consequences. Finally, the impact on the domestic industry is assessed by examining changes in production, employment, market share, profits and wages.

Countervailing duty cases begin when a petition is filed with the ITA and the ITC by either an interested party or the ITA itself. (A complete timetable for countervailing duty investigations is provided in figure 1.) If the ITA concludes that an investigation is warranted, then the ITC must reach a preliminary determination as to whether a "reasonable indication" of material in-

jury exists. A negative ITC determination terminates the proceedings, while a positive determination leads to additional investigation.

A preliminary affirmative ITA decision leads to the announcement of a preliminary estimate of the export subsidy and an order that importers make a cash deposit or post a bond equal to the estimate of the subsidy for each entry. If the preliminary ITA decision is negative, no deposit or bond is posted; however, the ITA investigation continues until it reaches a final decision. If the final ITA decision is negative, then the case is terminated; otherwise, the ITA must determine the final subsidy margin.

An affirmative final determination by the ITA leads to an ITC hearing in which all interested



parties participate. If the ITC finds no material injury, then the case ends. On the other hand, a finding of material injury by the ITC leads to an ITA order of countervailing duties against the imported merchandise. Such an order continues until revoked.

### **Section 731: Anti-dumping Legislation**

The legal purpose of anti-dumping legislation is to prevent two unfair practices: 1) price discrimination in which foreign firms sell in the United States at prices lower than they charge in their home markets, and 2) export sales in the United States at prices below the average total cost of production.<sup>8</sup> Both practices tend to lower the price of the good in the U.S. market causing U.S. consumers to purchase less of similar domestically produced goods. This decrease in demand harms the domestic industry by reducing profitability, sales, employment and other measures relative to a market without dumping. Although domestic consumers do benefit from the lower price, their interests are ignored by this legislation.

Focusing on the first practice, if the ITA determines that the product in question is being sold in the United States at a price less than its foreign market value, the case is referred to the ITC. The ITC then investigates whether, as a result of the dumping, a domestic industry is injured, likely to be injured or prevented from being established.

The ITC's assessment of material injury in dumping cases is the same as in countervailing duty cases. The ITA's determination of the dumping margin, however, differs from the determination of the subsidy margin. The dumping margin is simply the difference between the home market sales price and the export sales

price. While the concept of a dumping margin is simple, applying the concept to the real world is complicated.<sup>9</sup> Details on calculating the dumping margin, which can affect the consequences of this legislation, are highlighted later.

The administrative procedure for anti-dumping cases is virtually identical to that of countervailing duty cases. The primary difference is that while an injury test is automatic in anti-dumping cases, it may not be required in certain countervailing duty cases. In addition, the timetable for dumping investigations (provided in figure 2) is longer.

### **Section 301 and the Authority to Retaliate**

Section 301 grants the United States Trade Representative (USTR) authority (subject to any directions from the president) to take all "appropriate and feasible action" to remove foreign trade barriers that hinder U.S. exports and to fight foreign subsidies that hinder U.S. exports to third-country markets.<sup>10</sup> This legislation is primarily a Congressional response to dissatisfaction with GATT's ineffectiveness in resolving trade disputes.<sup>11</sup> Formally, Section 301 allows the USTR to respond against any act, policy or practice of a foreign country that is determined to be: 1) inconsistent with the provisions of, or otherwise denies benefits to the United States under, any trade agreement; or 2) unjustifiable, unreasonable, or discriminatory and burdens or restricts U.S. commerce.

Unreasonable is broadly defined in the Trade and Tariff Act of 1984 so that offending foreign restrictions are not limited to violations of trade agreements. The term includes, and goes beyond, any act, policy or practice that denies fair and equitable opportunities to begin and operate a business. Unjustifiable, as well as discrim-

<sup>8</sup>Boltuck (1991) identifies international price discrimination, promotional pricing, predatory pricing and hidden export subsidies as instances of price dumping. Note that for price dumping to be profitable, barriers must exist that prevent the imported good from being resold in the exporter's market at the higher home market price. International price discrimination is profitable when an exporter possesses more market power at home than in the United States (that is, demand in the firm's home market is less elastic than in the United States) and charges a higher price in its home market than in the United States. Promotional pricing arises when an exporter induces consumers in a foreign market to try a product by introducing it at a low price. Predatory pricing is a rarely used strategy in which an exporter attempts to eliminate competitors by reducing the export price below its rival's costs and below its own production costs. Once the competitors have ex-

ited the market, the exporter raises the price. Finally, hidden export subsidies are classified as dumping either because there is no direct subsidization or the ITA is unable to demonstrate the existence of a subsidy.

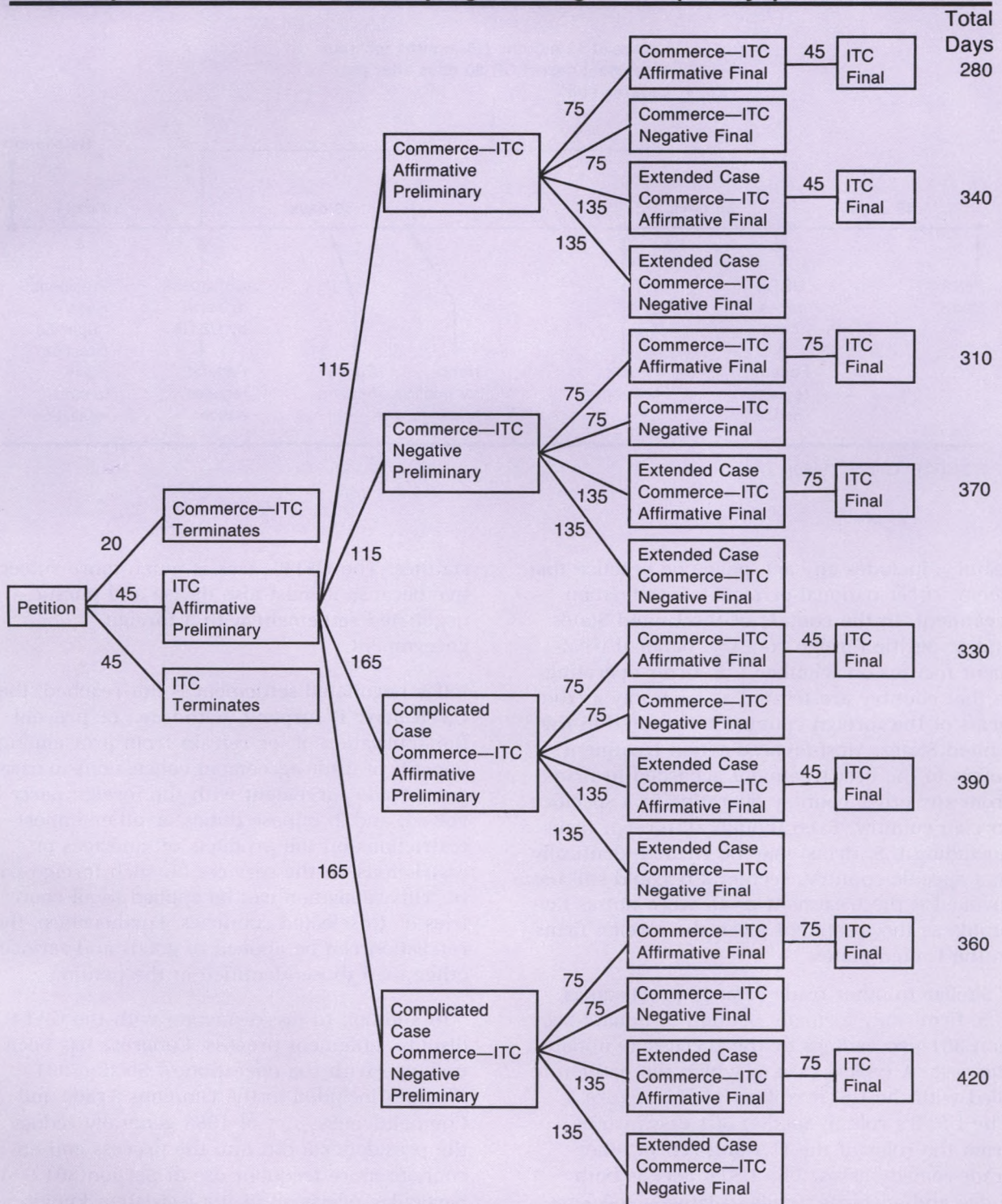
<sup>9</sup>See Jackson (1990) for details on this complexity.

<sup>10</sup>The President (rather than the USTR) had this authority prior to the Omnibus Trade and Competitiveness Act of 1988.

<sup>11</sup>Although GATT is frequently involved in dispute-settlement proceedings, it has no authority to impose sanctions or enforce its decisions. A GATT ruling favorable to the United States simply justifies unilateral U.S. action when the other party does not abide by the decision. In addition, Section 301 allows for the settlement of trade disputes with countries not belonging to GATT or when the issue is not covered by GATT.



Figure 2

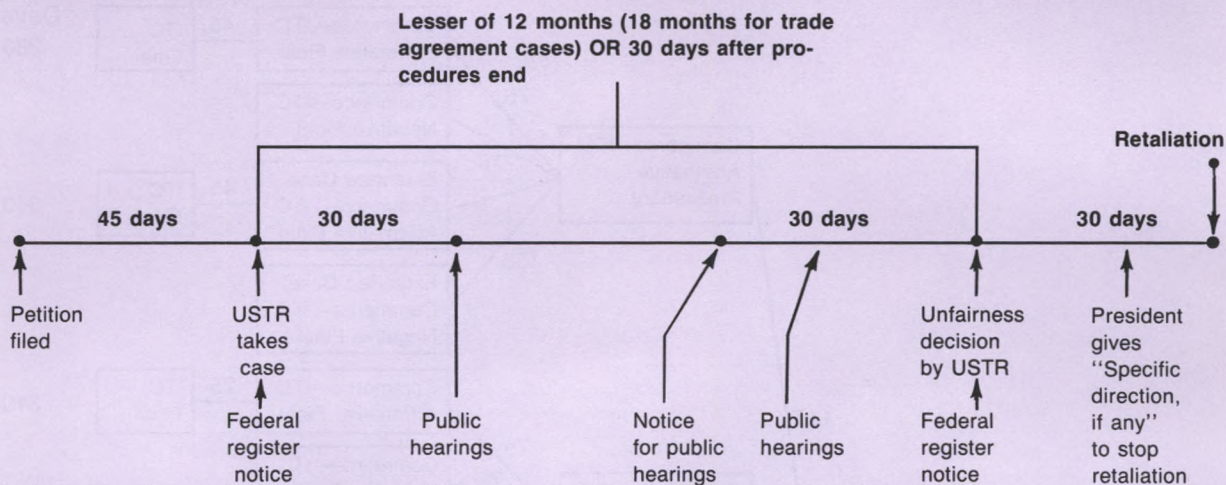
**Statutory Timetable for Anti-dumping Investigations (in days)**

SOURCE: United States International Trade Commission (1987).



Figure 3

### A Representative Case for the Section 301 Process



SOURCE: Grinols (1989).

inatory, includes any act, policy or practice that denies *either* national or most-favored-nation treatment. In the context of the United States and a specific foreign country, national treatment focuses on whether U.S. firms operating in that country are treated as favorably as the firms of the foreign country are treated in the United States. Most-favored-nation treatment refers to the best treatment accorded to firms from any other country operating in a specific foreign country. Even though all foreign firms (including U.S. firms) may be treated identically in a specific country, Section 301 could still be invoked if the treatment given were not as favorable as the treatment given the foreign firms in the United States.

Similar to other trade remedy proceedings, U.S. firms may formally petition to initiate Section 301 proceedings or the USTR may initiate the case. A typical case in which the petition is filed with the USTR is illustrated in figure 3. The USTR's role in Section 301 cases varies from the roles of the ITA and ITC in other trade-remedy cases. The USTR acts as both judge and advocate, while, relatively speaking, the ITA and ITC primarily judge on the basis of the objective merits as defined by the relevant

statutes. The USTR's task is much more subjective because it must also devise and pursue a negotiated settlement with a foreign government.

If a negotiated settlement is not reached, the USTR may: 1) suspend, withdraw, or prevent the application of, or refrain from proclaiming, benefits of trade agreement concessions to carry out a trade agreement with the foreign party involved; and 2) impose duties or other import restrictions on the products of, and fees or restrictions on the services of, such foreign party. This retaliation can be applied to all countries or to selected countries. Furthermore, the retaliation can be applied to goods and services other than those identified in the petition.

In addition to dissatisfaction with the GATT dispute-settlement process, Congress has been unhappy with the operation of Section 301. Changes included in the Omnibus Trade and Competitiveness Act of 1988 generally reduce the president's input into the process and encourage more frequent use of Section 301.<sup>12</sup> A particular provision of the legislation known as Super 301 reflected Congress' desire to "get tough" with our foreign rivals and pry open

<sup>12</sup>See Grinols (1989).



Table 2

**U.S. Trade-Remedy Petitions: Number and Percentage of Total**

	Escape clause		Anti-dumping		Countervailing duty		Section 301		Total petitions
1979	4	6.5%	16	25.8%	37	59.7%	5	8.1%	62
1980	2	5.4	24	64.9	11	29.7	0	0	37
1981	6	11.3	15	28.3	22	41.5	10	18.9	53
1982	1	0.5	63	29.2	145	67.1	7	3.2	216
1983	5	6.2	47	58.0	22	27.2	7	8.6	81
1984	6	4.5	73	54.9	52	39.1	2	1.5	133
1985	3	2.7	65	58.6	38	34.2	5	4.5	111
1986	3	2.9	70	66.7	26	24.8	6	5.7	105
1987	2	7.7	14	53.8	5	19.2	5	19.2	26
1988	2	3.2	40	64.5	13	21.0	7	11.3	62
1989	0	0	23	56.1	9	22.0	9	22.0	41
1990	1	1.8	43	76.8	8	14.3	4	7.1	56

SOURCE: Escape clause, anti-dumping and countervailing duty data for 1979-1988 are from Messerlin (1990). The remaining years of data are from the Office of the United States Trade Representative (1991). The data for Section 301, which includes petitions as well as cases instigated by the President of the United States and the USTR, is based on a listing from the Office of the United States Trade Representative.

their markets.<sup>13</sup> Super 301 required the USTR to name (by May 30 of each year) those nations with the most restrictive barriers to U.S. exports and to identify the specific practices that most hinder U.S. exports. The listed countries faced retaliatory measures if no agreement on removing the trade barriers was reached within 12 to 18 months.

### THE FREQUENCY OF TRADE-REMEDY PETITIONS

During the 1980s, import-competing firms throughout the world increasingly used anti-dumping actions rather than countervailing duty and escape clause actions.<sup>14</sup> As shown in table 2, this change has occurred in the United States as well; however, this change is not as pronounced in the United States as it is elsewhere. From 1983 onward, anti-dumping actions in the United States have exceeded 50 percent of the total number of trade-remedy petitions. In fact, the use of the escape clause mechanism has be-

come negligible. Since 1984, escape clause cases have generally totaled less than 5 percent of the petitions.

The total number of actions show a substantial decline since 1987. However, to argue that this decline indicates a sharp reduction in the demand for protection would be erroneous. Between 1982 and 1986, the total number of actions exceeded 100 cases in every year but one; however, approximately 200 cases involving steel products were initiated prior to the voluntary steel agreement of October 1984.<sup>15</sup> In addition, the duties imposed under anti-dumping and countervailing duty actions can persist for some time.<sup>16</sup> Similarly, other non-tariff barriers that were negotiated and imposed as a result of the pressure represented by anti-dumping and countervailing duty actions also persist for some time. Thus, many industries had their concerns resolved (at least temporarily) which resulted in a reduced number of new cases in the late 1980s.

<sup>13</sup>See Bhagwati and Patrick (1990), especially Chapter 1, for an overview of the reasons for and the issues generated by Super 301.

<sup>14</sup>See Messerlin (1990) for details.

<sup>15</sup>See Ahearn et al. (1990).

<sup>16</sup>According to the Office of the United States Trade Representative (1991), 71 countervailing duty orders were in effect at year-end 1990. These 71 orders exceed the total number of countervailing duty petitions (61) between 1986 and 1990.



The trend since 1987 of declining actions, however, is not exhibited by Section 301 petitions. On the other hand, there is no clear upward trend either. Recent legislative changes in the Omnibus Trade and Competitiveness Act of 1988 suggest that this mechanism will assume increasing importance in the future.

### **TRADE-REMEDY LAWS: THEIR EFFECTS AND THE ROLE OF ADMINISTRATIVE BIASES**

To assess the consequences of trade-remedy legislation, information on the frequency of these petitions is supplemented with details of their administration and outcome. The evidence presented below highlights biases in the administration of these laws and the proliferation of trade barriers resulting from these cases. As a result, it is highly unlikely that the legislation is facilitating free and fair trade.

#### ***The Negligible Effects of Escape Clause Legislation***

The small number of escape clause petitions in recent years suggests that this trade-remedy legislation is having virtually no effect on the pattern of trade. The underlying criteria for a successful petition, plus the possibility of foreign retaliation unless other U.S. trade barriers are reduced, have deterred the use of escape clause petitions and induced industries to seek protection using other trade-remedy avenues.<sup>17</sup> Despite the "requirement" that anti-dumping and countervailing duty actions can be invoked only to counteract the specific unfair trade practices of dumping and export subsidies, industries have increasingly resorted to these trade-remedy laws rather than use the escape clause route. This apparent anomaly is explained when the administrative details of these less-than-fair value procedures are scrutinized.

### ***Effects of Countervailing Duty and Anti-dumping Legislation and Administrative Biases***

Countervailing duty and anti-dumping actions are associated with rising trade barriers. For example, of 774 countervailing duty and anti-dumping cases completed in the United States between 1980 and 1988, 70 percent were resolved to restrict trade in some way.<sup>18</sup> Whether the resulting duties, as well as the other negotiated restrictions on trade, should be viewed as protectionist, however, requires additional information.

Countervailing and anti-dumping duties can be viewed as responses to actions taken by foreign governments and firms. For example, if an investigation determines that dumping is occurring, then the U.S. response to impose a duty (a dumping bond) equal to the dumping margin is automatic. In this case, the effect of the duty is to offset the injury to the domestic industry. If each instance of dumping is counteracted, then the net effect on trade would be zero in the sense that the level of trade would return to the same level prior to dumping. Many, however, do not feel that the actual workings of the legislation are quite so benign.

#### ***Administrative Biases***

Bias has been found to enter the administration of less-than-fair value statutes through their interpretation by administrative agencies.<sup>19</sup> The administering agencies have discretion that is sufficiently broad to allow for bias. For example, Boltuck et al. (1991) conclude that the procedures used by the ITA in measuring subsidy rates and dumping margins are biased toward finding dumping and export subsidies.<sup>20</sup>

A foreign firm is found to be dumping when the price of their good in the U.S. market is

<sup>17</sup>Article XIX of GATT allows trading partners affected adversely by an escape clause action to retaliate by withdrawing "substantially equivalent concessions" affecting the goods of the country invoking the escape clause. An alternative is to provide compensation to these GATT members by lowering trade barriers on their exports. See Hamilton and Whalley (1990) and Lande and VanGrasstek (1986) for additional details.

<sup>18</sup>See Finger and Murray (1990).

<sup>19</sup>Recent research has suggested another way that the administration of this legislation could be biased. Moore (1990) found that ITC anti-dumping decisions were biased toward affirmative decisions when the complaining industry was

located in the state of a senator on the Senate Finance Committee.

<sup>20</sup>See Kaplan (1991) for a demonstration of the protectionist bias in injury and causation determinations before the ITC.



below: 1) the price of the good in its home market; 2) the price of the good in a third market if no home market exists; or 3) its production cost. Such comparisons appear to be simple, but the description below suggests otherwise. Similarly, the measurement of subsidy rates appears straightforward with the focus on devising accounting rules to allocate government subsidies across the volume of exports. Closer inspection, however, indicates much complexity as well as the potential for bias in these calculations.

The calculation of price dumping margins is subject to error at four different stages: 1) in identifying the home (domestic) market; 2) in adjustments to make domestic and export products comparable; 3) in adjustments to calculate the *ex factory* price (that is, the price as it leaves the factory) of domestic and export products; and 4) in comparing the *ex factory* prices of domestic and export products. Errors at the first and last of these stages are illustrated.

The identification of the foreign firm's home market tends to produce the highest possible fair value of the foreign good and, thus, the largest possible dumping margin. To illustrate, assume a firm occasionally charges a price below its production cost in its home market. Such sales are made in the "normal course of business" for any firm in a competitive industry that faces a demand for its product that varies randomly.<sup>21</sup> Below-cost sales, that occur when demand falls below its average level, are balanced by above-cost sales, that occur when demand is above its average level, allowing the firm to earn a competitive rate of return. The

ITA, however, excludes all below-cost sales from its calculation which raises the fair value of the product and creates an upward bias in the dumping margin.

The comparison between the *ex factory* price of individual sales in the foreign firm's export market (that is, the United States) to the average *ex factory* price in its domestic market can produce bias as well. For example, if prices were declining and exports increased relative to home sales during the period used to assess the existence of dumping by the foreign firm, then a positive dumping margin would be found. The low-priced export sales at the end of the period and the high-priced home market sales at the beginning of the period would generate a positive margin. Note that dumping would be found in this case even if home and export prices were identical for every sale made on the same day.<sup>22</sup>

In theory, the preceding bias should also operate in the other direction to generate negative margins. In practice, however, this does not occur because the ITC excludes the possibility of negative dumping, not only on average, but on each individual price comparison. Thus, all export sales below fair market value carry a positive dumping margin, while all export sales above fair market value carry a margin of zero.<sup>23</sup> Consequently, a positive dumping margin will be found even when all sales are made at the same price on the same day and the weights on each sale are identical.<sup>24</sup> Thus, this procedure punishes foreign firms for not price discriminating because the only way to avoid dumping duties is to charge substantially more in the United States than in other markets.

<sup>21</sup>Fred Smith of the Competitive Enterprise Institute, as quoted by Bovard (1987), notes, "If the same antidumping laws applied to U.S. companies, every after-Christmas sale in the country would be banned."

<sup>22</sup>To illustrate this particular bias, assume the foreign firm's sales occur at the same *ex factory* price in both the United States and its home market. Let the price be \$10 in the first half of the investigation period and \$5 in the second half. The firm sells five units both in the United States and at home in the first half of the period and 15 units in the United States and 10 at home in the second half. The average home price is \$6.67 because one-third of the home sales occurred at \$10 and two-thirds at \$5. This average price is compared to the individual sales prices in the United States. Thus, each U.S. sale in the first half of the period would show a negative dumping margin (that is, dumping in the foreign firm's home market rather than in the United States) of \$3.33 because the sales price of \$10 exceeds the average home price of \$6.67; each sale in the second half of the period would show a positive dumping margin of \$1.67 because the sales price of \$5 is less than

\$6.67. One-fourth of the U.S. sales would have a negative dumping margin of \$3.33, while three-fourths of the sales would have a positive dumping margin of \$1.67. If this were the only bias in the ITA's calculations, a positive dumping margin of \$.42 would be calculated even though no actual dumping occurred. Additional biases, however, exacerbate the error further.

<sup>23</sup>In the numerical example in the preceding footnote, the one-fourth of the U.S. sales with the negative dumping margin of \$3.33 would be treated as having a zero dumping margin. This increases the calculated dumping margin to \$1.25 even though no actual dumping occurred.

<sup>24</sup>Boltuck et al. (1991) show that the bias in the margin equals approximately one standard deviation of the prices from the mean. Thus, if a company charges an identical price in the United States and other markets and its prices generally vary within 10 percent of the average price charged, the ITA will calculate a dumping margin of 10 percent. In other words, if the firm's average price is \$6.00, the bias in the dumping margin is about \$.60.



Similar bias exists in the ITA's calculation of subsidies in countervailing duty cases, especially when the subsidy is not in the form of a direct per unit export subsidy. Biased accounting methods provide one route for finding inequity. For example, assume a foreign firm produces more than one product and that one of the products is allegedly subsidized. If the firm is found to be subsidized, the ITA allocates the entire subsidy to the specific product that is the focus of the investigation irrespective of the degree, if any, to which the product is subsidized.<sup>25</sup>

Because of these sources of bias, virtually every investigation that proceeds to a formal determination finds in favor of positive dumping margins and export subsidies.<sup>26</sup> Thus, less-than-fair-value cases, similar to escape clause cases, hinge on injury tests. Since the criteria for the injury test are less stringent for less-than-fair-value than they are for escape clause cases, the infrequent usage of the escape clause is not surprising.<sup>27</sup>

### *Duties and Uncertainty*

The reasons for the protectionist consequences of less-than-fair-value legislation are not limited to biased administration. By law, any dumping margin or export subsidy greater than 0.5 percent justifies an affirmative determination. While a small duty is unlikely to have a large effect on competitiveness, the existence of any anti-dumping and countervailing duties creates costs of uncertainty that may have large effects for the exporter. This possibility is related to the fact that the importer (not the exporter) assumes the risk of incurring higher duties than those originally paid.

The bond initially posted on imports which are subject to these duties is only an estimate of the final duty. At the end of each year, the ITA allows interested parties the right to request a review of outstanding anti-dumping and counter-

vailing duty orders. Such a review will typically require three to four years before the final duty rate is set. If there is no request for a review, then the estimated deposit rate is equal to the final duty rate.

The uncertainty over deposit rates means that by importing under anti-dumping and countervailing duty orders, importers are creating open-ended contingent liabilities for themselves. Findings of underpayment require additional payments including interest to the government for the imports. To assess the risk of underpayment, an importer must have substantial information. For example, importers of goods subject to countervailing duties must be knowledgeable about the various industrial programs in the exporting country and be able to assess the bias that exists in the calculation of duties.<sup>28</sup>

### *Harassment*

Another line of argument suggesting the protectionist consequences of less-than-fair-value legislation is known as the harassment thesis. Gregory (1979) noted a barrage of administrative complaints or court suits (35) filed by U.S. electronic appliance and component manufacturers against Japanese competitors. He concluded that even when these actions are not directly successful, they impose lengthy and costly delays on Japanese firms that indirectly produce a protectionist result.

This harassment is not confined to Japanese firms nor are the consequences limited to increasing the cost of penetrating the U.S. market. Firms from virtually all developed countries as well as many developing countries have been subjected to less-than-fair-value petitions.<sup>29</sup> While these petitions directly increase the cost of penetrating the U.S. market, the threat of a petition also increases the risk of exporting to the United States for actual and potential exporters. The ultimate result is that foreign firms will reduce their efforts to export to the United States.

<sup>25</sup>See Boltuck et al. (1991) for additional examples.

<sup>26</sup>See Finger and Murray (1990).

<sup>27</sup>The fact that the president cannot set aside affirmative less-than-fair-value decisions but can set aside affirmative escape clause decisions, and that less-than-fair-value cases can be targeted against firms from specific countries while escape clause cases cannot, also explains the relative use of less-than-fair-value cases.

<sup>28</sup>This problem is not so pronounced in the case of dumping. An exporter that continued to dump would be sharing

revenue with the U.S. Treasury that it could have retained. Nonetheless, an exporter more concerned with short-term profits from price discrimination than with a long-term relationship with the importer might still find it profitable to price discriminate.

<sup>29</sup>Finger and Murray (1990) note that before a firm files a less-than-fair-value petition, it frequently makes inquiries with law firms and holds informal discussions with the ITA, neither of which are kept secret. In effect, the period of harassment can begin before an official complaint is lodged.



## *Non-tariff Barriers*

As suggested by arguments discussing uncertainty as well as harassment, less-than-fair-value legislation can have protectionist consequences apart from the actual duties resulting from specific cases. Another route to protectionism is that this legislation can result in the more frequent use of non-tariff barriers. Finger (1981) pointed out that less-than-fair-value mechanisms can be used by a domestic industry to generate public support for protection. Until all the standard means of seeking protection have been exhausted, it is unlikely that there will be strong political support for protection. Mechanisms such as less-than-fair-value cases must be utilized prior to gaining access to more political forms of protection. Many non-tariff barriers originated as less-than-fair-value cases. For example, Finger and Murray (1990) found that nearly half of the less-than-fair-value cases in the 1980s were superseded by some form of negotiated export restraint.

### *The Use of Less-Than-Fair-Value Legislation in Other Countries*

A final line of argument suggesting that less-than-fair-value cases lead to protectionism is that these cases induce other less-than-fair-value cases. As indicated by Messerlin (1990), this avenue of protection was not used by developing countries through 1985. The increased frequency of these cases by developed countries could have spurred their increased use by developing countries in the late 1980s. In 1988 more than 20 percent of anti-dumping actions originated in developing countries. Some have argued that use of this mechanism by developing countries is even more capricious than use by developed countries because importers may be subject to anti-dumping duties without either due process or even formal notification.<sup>30</sup> Thus, the use of less-than-fair-value legislation in the United States could backfire by generating additional inequities for U.S. producers—in this case, exporters—and in subjecting international trade to more barriers.<sup>31</sup>

## *Section 301 and Super 301: Controversial Consequences*

Although Super 301 has generated much controversy since its passage, it has produced only a small number of offenders and practices. In 1989, for example, Brazil was cited for quantitative restrictions involving her balance of payments; Japan was cited both for technical barriers to trade hindering forest products and government procurement practices involving supercomputers and satellites; and India was cited for barriers limiting trade in foreign insurance services and for trade-related investment measures that imposed export performance requirements on foreign investors. It is noteworthy that these priority practices were not necessarily those with the greatest export potential and that they were similar to those generally handled under Section 301. Nonetheless, these Super 301 actions generated protests from our major trading partners.<sup>32</sup>

Barfield (1990) criticizes the Super 301 process because it is ultimately controlled by the same political judgments the United States criticizes other countries for using in their trade policy decisions. For example, the naming of India and Brazil was in retaliation for their role as leaders of a group of developing countries that opposed U.S. goals in the Uruguay Round.

The politicization charge can be levied against the Section 301 process in general. Powell (1990) argues that voluntary export restraints on steel in the 1980s were highly politicized. In the course of the 1984 presidential campaign, Republican political leaders bowed to steel industry pressure for protection. Finding no other avenue available, the USTR threatened to file Section 301 cases unless numerous countries agreed to limit steel exports.

Other ways also exist to manipulate Section 301 cases. For example, in November 1987, the USTR invited public comment to identify potential Brazilian imports as targets for retaliatory tariffs in a computer piracy case. Representatives from various industries producing goods

<sup>30</sup>This point is made by Powell (1990) based on an interview with Robert McNeill, the executive vice chairman of the Emergency Committee for American Trade.

<sup>31</sup>A related point is that the filing of anti-dumping petitions in the United States is not limited to domestically owned firms. As reported by Bradsher (1991), the American manufacturing subsidiary of a Japanese company recently asked the ITC to impose duties on the imports of a com-

petitor that is 48 percent British-owned. This new type of trade complaint will likely cause some supporters of this legislation to reconsider their positions as it becomes clear that foreign-owned firms can benefit at the expense of U.S. consumers.

<sup>32</sup>See Bhagwati and Patrick (1990), especially Part 3, for the reactions to Section 301 by various U.S. trading partners.



unrelated to computers, such as leather shoes and dinner dishes, made appeals for retaliatory tariffs of 100 percent to the USTR.

Barfield (1990) also criticizes Super 301 because it violates the fundamental premises of GATT. GATT relies on negotiated reciprocal reductions of trade barriers on a multilateral basis across many industries. Actions in which countries unilaterally define unfair practices and force bilateral negotiations under a retaliation threat are antithetical to GATT. Since GATT is the foundation for an orderly world trading system, it is quite difficult to accept any argument suggesting that use of this legislation by the United States can facilitate free trade. It is more likely that other countries will develop their own versions of 301 legislation and that they will be used to counteract the United States. In such an environment, trade barriers will probably rise rather than decline.

A more fundamental criticism of Section 301 (in general) and Super 301 (specifically) is that trade retaliation and retaliatory threats are ineffective in opening foreign markets. After studying a large number of cases, Powell (1990) concluded that this "crowbar" approach generally fails and that markets are opened because of domestic conditions rather than external ones. From 1975 through March 1990, only 13 of 79 Section 301 cases that were filed led to market openings.<sup>33</sup> In many cases, countries have responded to retaliation by further closing their markets.

Numerous reasons are offered to explain the ineffectiveness and shortcomings of this approach to open foreign markets. First, nationalism in the target country is inspired by retaliation; a coercive attempt by a foreign government tends to unite the target country against the threat. Second, the target country reorients its economy toward alternative suppliers and markets. Firms and consumers in targeted countries can replace their transactions with the

United States by selling to and purchasing from other countries. Third, the government's role in the target country generally expands. This intervention to manage the changes induced by the retaliation involves trade-distorting policies, many of which are difficult to eliminate once they have been instituted. Fourth, the tougher the sanctions, the larger the costs incurred by the retaliating country in terms of higher consumer and input prices.<sup>34</sup>

The preceding assessment, however, is not shared by everyone. Ahearn et al. (1990) note a congressional perception in recent years that Section 301 and Super 301 are working. The 1989 Super 301 complaints against Japan and Brazil were resolved in 1990. In addition, South Korea and Taiwan, both frequently mentioned as potential targets of Super 301, made advance concessions to avoid being named as priority countries.<sup>35</sup> Nonetheless, even in situations where this legislation is generating results, it is far from clear that barriers to trade are actually being reduced. For example, recent U.S.-Japan discussions (known as the Structural Impediments Initiative) were largely a Section 301 negotiation. It can be questioned whether the U.S.-Japan agreement to reduce structural impediments to trade, such as Japanese "concessions" to review tax policies that favor agriculture over new construction and American "concessions" to reduce its budget deficit, will promote a freer trading environment or even reduce the U.S. bilateral trade deficit with Japan.<sup>36</sup>

## CONCLUSION

The alleged purpose of nearly all trade-remedy laws is to ensure that international competition is fair. Certain commercial practices, such as dumping and export subsidies, are viewed as unfair and, thus, should be counteracted. The elimination of these unfair practices will produce an economic environment in which the

<sup>33</sup>Powell (1990) found that some openings for U.S. exports to South Korea have led to new restrictions on imports from other countries, especially those from Japan. Thus, the South Korean market is not more open overall. While the actions by South Korea have served the interests of certain U.S. exporters, the actions reflect the fact that political clout rather than economic efficiency is determining the pattern of trade.

<sup>34</sup>Numerous examples are available to suggest the harm. In 1988, President Reagan imposed 100 percent tariffs on Brazilian paper products, pharmaceuticals and consumer electronics as a result of a Section 301 petition alleging inadequate Brazilian protection of pharmaceutical patents. In

1982, President Reagan ordered higher steel tariffs and more restrictive import quotas as a result of a petition charging European steel subsidies. While U.S. steel producers undoubtedly benefited, American manufacturers that required competitively-priced steel as an input were harmed.

<sup>35</sup>The 1989 Super 301 complaints involving two practices in India remain to be resolved. A review is to be conducted after the conclusion of the Uruguay Round.

<sup>36</sup>See Butler (1991) for details on these negotiations as well as for a general overview of U.S.-Japan trade.



success of firms and resource suppliers depend on their own performance in a competitive market rather than on their access to government subsidies or the use of questionable practices.

Reality, however, bears little resemblance to the alleged purpose. Less-than-fair-value trade laws, especially anti-dumping laws, are the most frequently used trade-remedy laws and provide potential relief from all imports, whether they are traded fairly or unfairly. In fact, the operations of these laws are biased toward findings of dumping and export subsidies. Therefore, they have become standard devices to protect specific domestic producer interests at the expense of domestic consumer and other producer interests. In addition, U.S. less-than-fair-value trade laws explicitly instruct administrators to protect specific domestic producers, while ignoring the interests of domestic consumers and other domestic producers.

The costs imposed by the increasing use of less-than-fair-value trade laws are not restricted to the consequences of the actual import duties. The threat of such cases leads to "voluntary" agreements to limit trade, agreements that harm potential importers. Furthermore, the uncertainty associated with the actual duties collected functions as a type of non-tariff barrier. Finally, there is evidence that the use of trade-remedy laws tends to encourage protectionism in other countries.

Despite some instances where Section 301 and Super 301 cases might have had positive effects in liberalizing foreign markets, there is substantial evidence suggesting that the crowbar approach generally fails. Domestic conditions rather than external pressures provide the primary motivation for the liberalization of markets. Nonetheless, there is a high probability that this trade-remedy approach will be used more frequently in the future. If so, then other countries are likely to develop and use their own versions of 301 legislation to counteract the United States' actions. Similar to the world's experience with less-than-fair-value laws, protectionism is a likely consequence.

Overall, the evidence is that trade-remedy laws hinder rather than facilitate free trade. U.S. fair trade laws can be more accurately characterized as the bedrock for protectionism rather than the bedrock for free trade. As such, trade-remedy laws need to be remedied by elim-

inating the bias toward protection of domestic producers.

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# The Behavior of Retail Gasoline Prices: Symmetric or Not?

**S**INCE DEREGULATION in the early 1980s, crude oil prices have been allowed to move freely with market conditions. Because of oil supply shocks and seasonal movements in gasoline demand, retail gasoline prices often fluctuate more widely than consumer prices in general. Some analysts and politicians have criticized these retail gasoline price movements, alleging that they do not respond symmetrically to price changes at earlier stages of the marketing chain. In particular, they believe that retail gasoline prices do not reflect decreases in oil and wholesale gasoline prices as rapidly and fully as they do price increases. The shaded insert on page 20 contains comments typical of this line of criticism. The perceived asymmetry in retail gasoline price movements is of special concern to consumers who believe that they are being "gouged" by the oil industry.

Much of the perception of possible asymmetry focuses on the relationship between the price of oil and the retail price of gasoline. This suggests

that oil producers or refineries are principally responsible for the asymmetry. In fact, a survey undertaken by the American Petroleum Institute concluded that 80 percent of Americans believed that *oil companies* artificially raised the price of gasoline after Iraq's invasion of Kuwait on August 2, 1990.<sup>1</sup> This statistic suggests that many Americans believe retail gasoline stations are owned and operated by the oil refiners. In some cases this is true, but much of the gasoline sold at the retail level is sold through outlets that are not owned by the oil producers and refiners. The fact that many retail outlets are "independent" suggests that they have some autonomy in setting the retail price. The role these retailers play in the perceived asymmetry is largely ignored, even though they are as much a possible source of such an asymmetry as are the oil producers and refiners.<sup>2</sup> This article analyzes the role that retailers may play in the perceived asymmetric movement of retail gasoline prices. Specifically, we test whether

<sup>1</sup>McKenzie (1991).

<sup>2</sup>An article by Solomon (1990), however, does point out the potential role of retail outlets. See "Gasoline Prices Resist Crude Behavior."



## What Goes Up Need Not Come Down?

"Those who are doing the gouging will hear from the president." —Treasury Secretary Nicholas Brady. *The Wall Street Journal*, (Shribman and McQueen) August 9, 1990.

"Retail (gasoline) prices go up much faster than they come down." —a spokesman for the Automobile Association of America. *The Wall Street Journal*, (Solomon) August 9, 1990.

"Pump prices are fast to respond to rising prices but slower to fall when crude prices fall." —Antonio Szabo, oil consultant with Bonner & Moore. *The Wall Street Journal*, (Business Bulletin) August 3, 1989.

"Whenever oil prices fall, there is always this stickiness in gasoline prices on the way down. You never see this stickiness on the way up." —Ed Rothschild, energy expert at Citizen Action. *New York Times*, (Wald) July 2, 1990.

"When crude prices go up, product prices tend to rise with crude prices. But when crude prices go down, product prices tend to lag—they go down slowly." —John Hilton, oil industry analyst for Argus Research Corp. *St. Louis Post-Dispatch*, (Crudele) June 19, 1990.

wholesale gasoline price increases are passed along to the retail customer more fully and rapidly than are wholesale gasoline price decreases.

### GASOLINE DISTRIBUTION, PRICING AND MARGINS

The purchase of gasoline at the retail pump is the end of a long and complicated marketing chain. A simplified illustration of how oil, after undergoing refining, reaches the consumer as gasoline is shown in figure 1. From the oil fields, oil is moved to the refineries either by tanker, pipeline, or a combination of the two. The refinery receiving the oil may be owned by the company that produced the oil or may be independent. On January 1, 1990, 205 U.S. refineries, owned by over 100 companies, were in operation.

At the refinery, oil is distilled into a variety of products including gasoline, home heating oil, diesel oil, jet fuels, asphalt, kerosene and lubricants. One barrel of oil (42 U.S. gallons) yields about 43 percent gasoline.<sup>3</sup> Gasoline is transported from the refinery by truck, pipeline, tanker or barge. Some is moved directly from the refinery to retail outlets; some is moved from the refinery to terminal storage areas closer to final consumption. From these storage

areas, the gasoline is generally moved to the point of final sale by truck. Once the gasoline reaches its final destination before purchase, it is usually stored in large underground tanks.

Refiners may sell gasoline directly to "end users" such as large trucking firms, industrial manufacturers and utilities. They may also sell directly to retail gasoline outlets. Retail gasoline stations owned by the refining company are classified as "end users." Retail gasoline stations not owned by refining companies are known as "independents." As figure 1 shows, sales to end users accounted for about 19 percent of refiners' gasoline sales, by volume, in 1988, with 17 percent of the sales to company outlets and 2 percent to other end users.

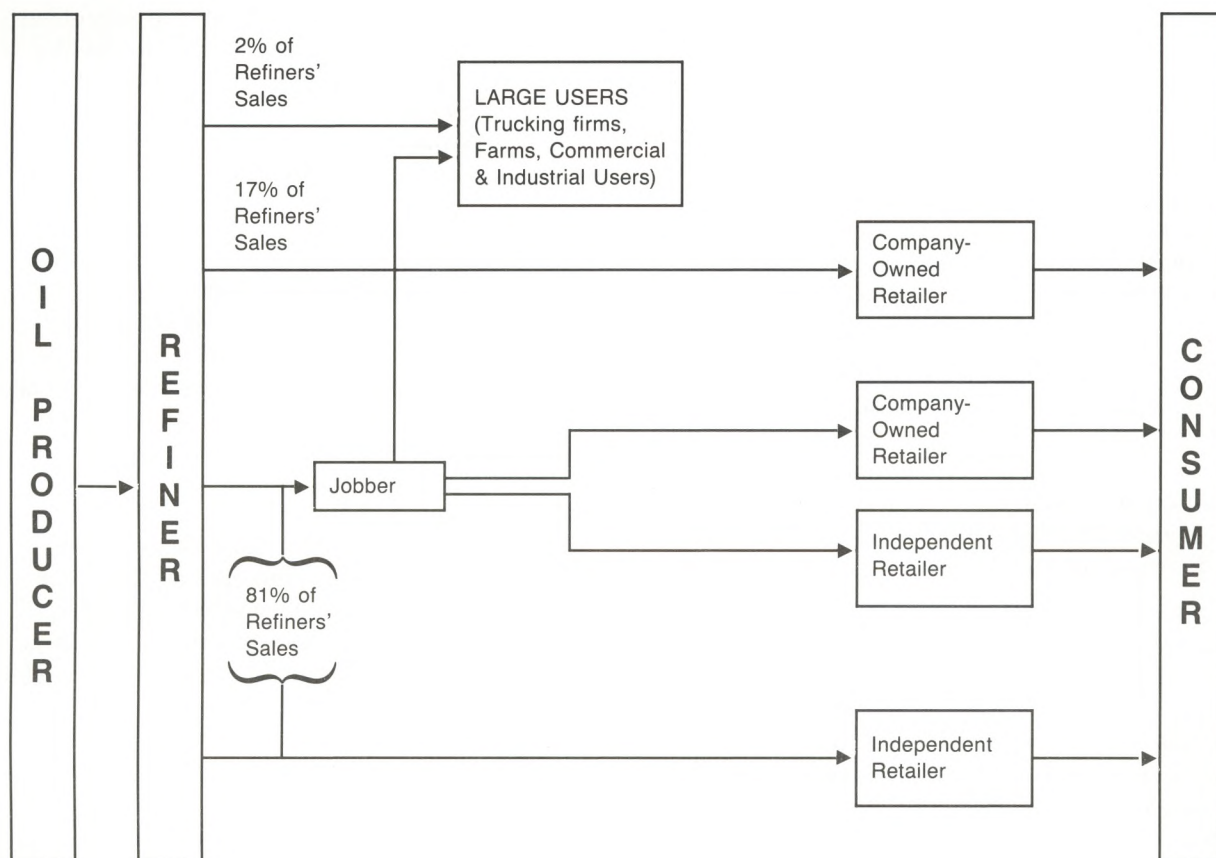
The other 81 percent of refiners' gasoline sales are made to either "jobbers" or independent retail outlets. Jobbers purchase gasoline from the refiners which they in turn sell and distribute to retail stations and large users. Gasoline sales made by refiners to the non-company-owned retail outlets and to jobbers are referred to as "sales for resale."

Several different entities are involved in the pricing of gasoline as it is moved from the oil field to the retail gasoline outlet. When oil is sold to the refinery, the price for this transaction is called the producer price. The price charged for gasoline by the refiner or jobber to

<sup>3</sup>See Anderson (1984, p. 216).



**Figure 1**  
**Oil and Gasoline Distribution Channels**



1. Based, in part, on information provided in Dougher and Jones (1990), p. 7.

the retail gasoline station is called the wholesale price.<sup>4</sup> The price the gasoline station charges the consumer is called the retail price. The differences between prices at various levels in the marketing chain are called "margins." The difference between the retail and wholesale price

is called the wholesale-retail margin. The difference between the wholesale price and producer price is called the producer-wholesale margin. The overall difference is called the producer-retail margin.

<sup>4</sup>The price that the jobber pays the refiner is included in the "sales for resale" price series used in this study.



## DEFINITIONS OF ASYMMETRIC GASOLINE PRICE MOVEMENTS

Retail price movements are defined as asymmetric if an increase in the wholesale price affects the retail price differently than an equal-sized decrease. Three types of asymmetry are defined. The first deals with the length of *time* in which a wholesale price change works its way through to the retail level. For example, is an increase in the wholesale price passed along more quickly to the retail level than an equal-sized wholesale price decrease?

The second type of asymmetry deals with the *amount* of a wholesale price change that passes through to the consumer. For example, does a 10-cent increase in the wholesale price lead to a 7.5-cent increase in the retail price, while a 10-cent decrease in the wholesale price leads to only a 5-cent decline in retail price?

The third type of asymmetry is a combination of time and amount. The pattern of retail price response may differ for wholesale price increases and decreases. Although the retail price may adjust to a wholesale price increase and decrease by an equal total amount and length of time, the amount of adjustment in each period may not be equal for price increases and decreases.

For example, in cases where the wholesale price increases and decreases 10 cents per gallon, retail prices may require two months to completely respond to both wholesale price changes. Assume the retail price increases and decreases 9 cents per gallon in response to the wholesale price increase and decrease, respectively. In such a situation, symmetry exists with respect to both the timing and amount of retail price movements. The pattern of the retail price response might be to increase (decrease) 7 cents in the initial month and increase (decrease) 2 cents in the month following a wholesale price increase (decrease). This pattern is symmetric. However, the pattern could be such that the retail price rises 7 cents and 2 cents in the first two months for a wholesale price increase, while the retail price falls only 3 cents in the initial month and 6 cents in the second month in response to a wholesale price decrease. This pattern is not symmetric.

Since producers, wholesalers and retailers all play a role in the determination of the retail price of gasoline, the perceived asymmetric price movements in the industry could be occurring between the producer and wholesale level or the wholesale and retail level. As noted earlier, many discussions of the perceived price asymmetry in the gasoline industry focus on the producer-retail price margin. Such a focus on the producer-retail margin tends to mask the role that retailers play in determining the producer-retail margin. Indeed, the perceived asymmetry may as readily be due to retailer behavior. In this case, simply observing the producer-retail price margin would not allow us to determine who is responsible for any asymmetry.

Price-movement asymmetry has been found to exist in several commodity markets, including oranges, lemons, dairy products, some fresh vegetables, pork and beef. In addition, the markup of price over cost in durable and non-durable manufacturing has been found to vary over the business cycle.<sup>5</sup> Thus, a finding that price movement asymmetry exists in the retail gasoline market would not be unique. Many of the works cited above indicate the importance of industry concentration as a factor in explaining the existence of asymmetry in these markets. Kinnucan and Forker (1987) note that "because of industry concentration . . . , it is commonly asserted that middlemen use market power to employ pricing strategies which result in complete and rapid pass-through of cost increases but slower and less complete transmission of cost savings."

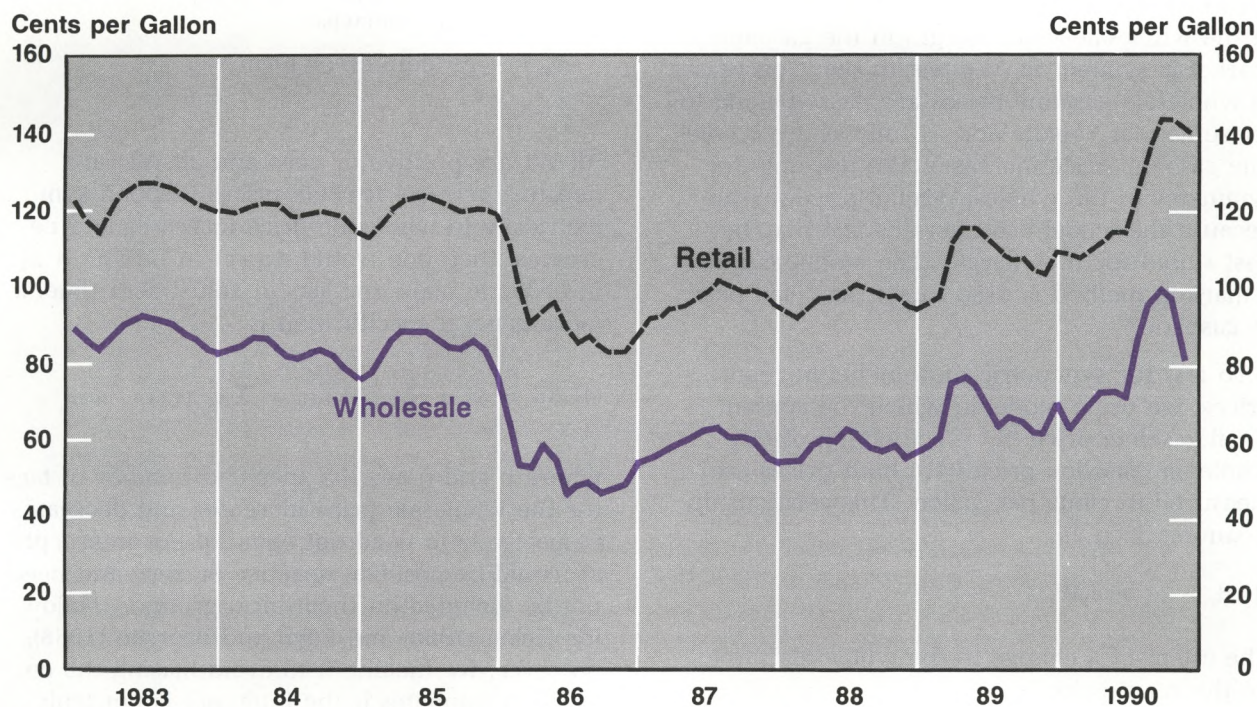
## GASOLINE PRICES AND CONSUMPTION

The U.S. average retail and wholesale prices of gasoline are shown in figure 2 for the period examined (January 1983 to December 1990). Several intervals of relatively large and rapid wholesale price changes are shown in the figure. In early 1986, following the collapse of oil prices, wholesale gasoline prices dropped sharply. In the spring of 1989, gasoline prices rose sharply due "in part because of the temporary closing of the port of Valdez, Alaska, at the terminus of the Trans-Alaska pipeline, after the

<sup>5</sup>Pick et al (1990), Kinnucan and Forker (1987), Ward (1982), Heien (1980) and Hahn (1990) all find asymmetry in the agricultural markets. Domowitz et al (1988), Bills (1987) and Morrison (1988) find asymmetric markups in the manufacturing sector.



**Figure 2**  
**U.S. Average Retail and Wholesale Gasoline Prices<sup>1</sup>**



<sup>1</sup>Retail prices include federal and state tax.

Exxon Valdez oil spill in March.”<sup>6</sup> The jump and subsequent decline in prices in late 1990 are associated with an OPEC oil price increase prompted by Iraq in late July 1990, the subsequent Iraqi invasion of Kuwait and the world embargo of Iraq-Kuwait oil. In all instances, the retail price appears to parallel the wholesale price quite closely. A more detailed and systematic analysis is necessary to determine if there is indeed a symmetric response in retail prices to a wholesale price increase and decrease. Although not shown in figure 2, the wholesale and retail prices of different grades of gasoline (premium, unleaded regular and leaded regular) also

exhibit similar parallel movements with wholesale price changes.

Since the analysis below examines asymmetry for different gasoline grades, it is useful to note the relative importance of these fuels. The mix of different grades of gasoline has changed substantially during the last 30 years. Prior to 1975, leaded gasoline accounted for over 50 percent of all motor gasoline fuel sales. Leaded gasoline's market share began to decline, however, after the enactment of environmental laws that required automobiles to burn unleaded gasoline and refiners to reduce the lead content of their

<sup>6</sup>See Wald (1990).



gasoline. Today, leaded gasoline accounts for only about 17 percent of total motor gasoline consumption, while unleaded regular and premium gasoline account for 59 percent and 24 percent, respectively.<sup>7</sup>

## TESTING THE WHOLESALE-RETAIL MARGIN FOR SYMMETRY

The hypothesis considered is that movement in the wholesale-retail margin in the gasoline market is symmetric. We test to see if decreases in wholesale gasoline prices are passed along to consumers as rapidly and as fully as are wholesale gasoline price increases. We test only for symmetry in the wholesale-retail price margin because the model used for this test may be best suited for this margin. The model assumes a markup method is used to set the retail price of gasoline.<sup>8</sup>

To test for symmetric movements in retail prices, we use a model in which the current retail gasoline price ( $R_t$ ) is a function of the wholesale gasoline price ( $W_t$ ); both prices are measured in cents per gallon. This relationship is summarized as

$$(1) R_t = a_0 + a_1 W_t.$$

The effect of a change in the wholesale price on the retail price is

$$(2) R_t - R_{t-1} = a_1(W_t - W_{t-1}).$$

In order to examine how the affect of a wholesale price increase differs from that of a decrease, periods of wholesale price increases and decreases must be separated.

Following an approach similar to that developed by Wolfram (1971), this segmentation can be achieved using the model

$$(3) \Delta R_t = a_1 W I_t + a_2 W D_t + e_t,$$

where

$$\Delta R_t = R_t - R_{t-1},$$

$$W I_t = W_t - W_{t-1}, \text{ if } (W_t - W_{t-1}) > 0, \\ \text{and} = 0 \text{ otherwise,}$$

$$W D_t = W_t - W_{t-1}, \text{ if } (W_t - W_{t-1}) < 0, \\ \text{and} = 0 \text{ otherwise,}$$

$$e_t = \text{a random error term.}^9$$

All  $W I_t$  are positive or zero and all  $W D_t$  are negative or zero. If retail prices respond symmetrically to wholesale price increases and decreases, then one would expect to find  $a_1 = a_2$ . In order to allow for lags in adjustment time, a more general specification is

$$(4) \Delta R_t = a'_0 + \sum_{i=0}^p a_{1,i} W I_{t-i} + \sum_{i=0}^q a_{2,i} W D_{t-i} + e_t$$

where  $p$  and  $q$  are the specified number of lags for the wholesale price increases and decreases, respectively ( $p$  need not equal  $q$ ). An intercept,  $a'_0$ , could be positive, negative or zero and need not be included on theoretical grounds. Following Heien (1980) and Boyd and Brorsen (1988), however, we include it to avoid biasing the coefficient estimates if the intercept is not truly zero. This variable captures the average influence of all other factors besides raw material price changes that influence the retail price.<sup>10</sup>

Differences in the *timing* of price pass-through would be indicated by differences in the number of lags for increases ( $p$ ) and decreases ( $q$ ). The test of interest for the *amount* of pass-through now becomes testing the equality  $\sum_{i=0}^p a_{1,i} = \sum_{i=0}^q a_{2,i}$ . In other words, is the cumulative

<sup>7</sup>Based on volumes of first sales of motor gasoline in the *Petroleum Marketing Annual* [U.S. Department of Energy, (1988)], p. 216.

<sup>8</sup>This approach seems to more accurately represent the pricing behavior of retail outlets than oil refiners. Refiners with several oil products are perhaps more likely to employ a more sophisticated pricing mechanism than the retailer with a narrower range of oil products. One could make the argument, however, that retail outlets also have a multi-product pricing function, especially if the station is associated with a convenience store. Dougher and Jones (1990) note suggestions that low margins on gasoline may be offset by higher margins on convenience foods.

<sup>9</sup>Wolfram's procedure uses the level of the dependent variable, while we use the first difference of the dependent

variable. The model was also run for unleaded gasoline using the natural logs of all variables. The results are similar to those using the first-difference data.

<sup>10</sup>In some studies, a variable to measure changes in other major marketing margin cost components, such as labor, transportation and packaging materials, has been included in equation 4. Preliminary estimates for this study that included transportation wages and/or service station wages showed that neither variable was statistically significant.



effect of a wholesale price increase equivalent to that of a wholesale price decrease? If wholesale price changes are fully reflected in the retail price, we would expect to see  $\sum_{i=0}^p a_{1,i} = 1$  and  $\sum_{i=0}^q a_{2,i} = 1$ . Symmetry in the pattern of retail price response cannot be rejected if  $p$  equal  $q$  and all  $a_{1,i} = a_{2,i}$ .

## DATA AND ESTIMATION PROCEDURE

January 1983 through December 1990, a period of relatively little government intervention in the gasoline market, was chosen as the period of analysis. Honeycutt (1985) notes that a "... factor that influenced gasoline marketing, beginning in August 1971 and continuing to January 1981, was extensive federal intervention in the marketplace."<sup>11</sup> Furthermore, he notes that "statements by several major refiners that any changes in gasoline marketing would be phased in gradually suggest that not all important responses to decontrol had occurred by September 1981."<sup>12</sup> In order to allow time for these "important responses" to have little or no effect on the results, the period studied here starts in January 1983. During the period analyzed, the number of months with price increases and decreases for retail and wholesale prices was roughly equal across all grades of gasoline.

The retail prices used are tax-adjusted U.S. City Average Retail Prices of Motor Gasoline.<sup>13</sup> The prices used were reduced by the sum of the federal gasoline tax and a simple average of the 50 states' gasoline tax.<sup>14</sup> No attempt was made to interpolate tax rates between months where tax rates were actually observed. The most current reported tax rates were used until new tax data became available.<sup>15</sup>

Wholesale prices are those from data referred to as "Sales for Resale."<sup>16</sup> These are sales of refined petroleum products to purchasers who are "other-than-ultimate consumers." This series does not include refined petroleum product sales made directly to end users, such as agriculture, industry and utility consumers or sales made by refiners to company-operated retail outlets. Wholesale prices are reported exclusive of taxes.

## RESULTS

Equation 4 was estimated for premium, unleaded regular and leaded regular gasoline. Preliminary estimates of lag lengths were selected using Akaike's (1970) Final Prediction Error (FPE) criterion.<sup>17</sup> The FPE procedure used to estimate the "best" lag length requires the user to specify a maximum lag length. For our data, the lag lengths selected by the FPE procedure were sensitive to alternative maximum lag lengths.<sup>18</sup>

<sup>11</sup>Honeycutt (1985), p. 108.

<sup>12</sup>Ibid., p. 113.

<sup>13</sup>The unadjusted data are calculated by the U.S. Bureau of Labor Statistics and reported in the U.S. Energy Information Agency's *Monthly Energy Review*. These prices include all federal, state and local taxes paid at the time of sale. For the period 1978 forward, prices were collected from a sample of service stations in 85 urban areas selected to represent all urban consumers—about 80 percent of the total U.S. population. Service stations are selected initially, and on a replacement basis, in such a way that they represent the purchasing habits of the Consumer Price Index population. Service stations in the current sample include those providing all types of service (i.e., full, mini and self-serve). See *Monthly Energy Review*, February 1989, p. 106. Retail prices are collected at different stations during the month of estimation.

<sup>14</sup>Taxes were removed from the retail price using information provided in the U.S. Department of Energy's *Petroleum Marketing Monthly*. Federal and state motor fuel taxes are reported by the agency about twice a year (generally those effective on January 1 and July 1).

<sup>15</sup>Handling the tax rate changes in this manner could bias the results because tax rate changes that occur between reported tax rate changes are not accounted for until the next reporting month.

<sup>16</sup>See the U.S. Department of Energy's *Petroleum Marketing Annual* and the *Petroleum Marketing Monthly*. This price series is based on information provided to the Energy

Information Agency by firms responding to two separate surveys. The first survey, EIA-782A, "Refiners'/Gas Plant Operators' Monthly Petroleum Product Sales Report," is sent to a census of about 200 refiners and gas plant operators. The second survey, EIA-782B, "Reseller/Retailers' Monthly Petroleum Product Sales Report," is sent to about 3,000 resellers and retailers. Some of the firms in this survey are replaced on an annual basis. In both surveys, firms are surveyed on a monthly basis and are asked to report prices on a monthly volume-weighted basis.

<sup>17</sup>Batten and Thornton (1984) note that the FPE criterion attempts to balance the "risk" due to bias when shorter lag lengths are selected against the "risk" due to the increase in variance when longer lag lengths are chosen. Thornton and Batten (1985) point out that the FPE procedure gives relatively more importance to a lack of bias than efficiency. They argue that the procedure is asymptotically inefficient in that, on the average, it selects lags that are too long in large samples.

<sup>18</sup>Maximum lag lengths of six, nine and 12 months were specified in the FPE procedure. Results for the six-month and nine-month maximum were identical, although the 12-month maximum model chose longer WI lags (10 months) for premium and unleaded regular gasoline. Lag lengths suggested by the six- and nine-month maximum lag length models were used in estimating equation 4.



Table 1

### Symmetry Tests For Different Grades of Gasoline from January 1983-December 1990

Type of gasoline	Timing		Amount					
	Number of months lagged		Price parameter estimates		t-value for test of		R <sup>2</sup>	D.W.
	WI	WD	Increase $\Sigma a_{1,i} = 0$	Decrease $\Sigma a_{2,i} = 0$	$\Sigma a_{1,i} = \Sigma a_{2,i}$	$\Sigma a_{1,i} = 1$ $\Sigma a_{2,i} = 1$		
Premium	1	1	.98* (18.28)	.90* (16.98)	.88	.34 1.79	.91	1.94
Unleaded regular	1	1	1.03* (18.64)	.99* (17.64)	.46	.53 .22	.92	2.15
Leaded regular	1	2	1.10* (19.58)	1.05* (16.93)	.49	1.70 .80	.92	2.29

Note: Numbers in parentheses are the absolute values of the t-statistics.

\*Indicates statistical significance at the 5 percent level.

After estimating the model with the lag lengths suggested by the FPE procedure, F-tests and t-tests were performed to see if any of the lags (incrementally or as a group) could be eliminated as statistically insignificant. Only the significant lags are reported below.<sup>19</sup> Significant first-order autocorrelation was not present in any of the estimated equations.

### Timing Symmetry

The ordinary least squares estimates for equation 4 are summarized in table 1. Lag lengths used for periods of wholesale price increases were the same across all grades of gasoline; lag lengths used for periods of wholesale price decreases were the same for premium and unleaded regular. Leaded regular gasoline had a slightly longer lag length for wholesale price decreases. These models suggest that wholesale price increases affect retail prices for two months (the initial month plus a lagged month). Similarly, wholesale price decreases affect the retail price of premium and unleaded regular gasoline for two months. For leaded regular gas-

oline, however, wholesale price decreases affect the retail price for three months. Thus, the hypothesis that the length of time in which retail prices completely respond to a wholesale price change is symmetric cannot be rejected for premium and unleaded regular gasoline but can be for leaded regular gasoline.

### Amount Symmetry

Since the impact of the wholesale price change on the retail price is distributed over more than one month, the test for symmetry in the amount of pass-through examines whether the total response to a wholesale price increase is equal to the total response to a wholesale price decrease. In other words, is  $\sum_{i=0}^p a_{1,i} = \sum_{i=0}^q a_{2,i}$ ? The results of this test are shown in table 1. For all grades of gasoline, the cumulative response of retail prices to a wholesale price increase is no different from that to a wholesale price decrease. In addition, the hypotheses that  $\sum_{i=0}^p a_{1,i} = 1$  and  $\sum_{i=0}^q a_{2,i} = 1$  cannot be rejected for any grade of gasoline. This implies that wholesale price decreases are fully passed along to

<sup>19</sup>The reported lag lengths are those suggested by the FPE criterion except for premium's WI (for which the FPE procedure suggested a lag length of three months), and unleaded's WD (for which the FPE procedure suggested a lag length of two months).



**Table 2**  
**The Pattern of Retail Gasoline Price Response**

	Equation 4 Parameter Estimates					
	Wholesale increases		Wholesale decreases			$a'_0$
	$a_{1,0}$	$a_{1,1}$	$a_{2,0}$	$a_{2,1}$	$a_{2,2}$	
Premium	.64* (14.39)	.34* (7.62)	.29* (6.43)	.62* (11.57)	—	-.16 (1.02)
Unleaded regular	.68* (14.97)	.35* (7.71)	.30* (6.41)	.69* (12.65)	—	-.08 (.50)
Leaded regular	.76* (17.21)	.34* (7.69)	.23* (5.13)	.68* (12.85)	.14* (3.05)	-.07 (0.41)

Note: Numbers in parentheses are the absolute values of the t-statistics.

\*Indicates statistical significance at the 5 percent level.

consumers, as are wholesale price increases. In short, the hypothesis that the amount of pass-through in the retail gasoline market is symmetric cannot be rejected for the period of investigation.

### *Pattern Symmetry*

Even though the time it takes retail prices to respond fully to wholesale price changes and the total amount that retail prices respond to wholesale price changes are symmetrical, there is a difference in the pattern of response to wholesale price increases and decreases. The coefficient estimates for equation 4 are graphically shown, by grade of gasoline, in figure 3. For wholesale price increases, the largest retail response occurs in the current month for all grades of gasoline. But, for wholesale price declines, retail prices respond relatively little in the first month, and make their largest adjustment in the month following the wholesale price decline.

Using the premium gasoline model as an example, a direct interpretation of the coefficients, as reported in table 2, is as follows: a 10-cent increase in the wholesale price leads to a 6.4-

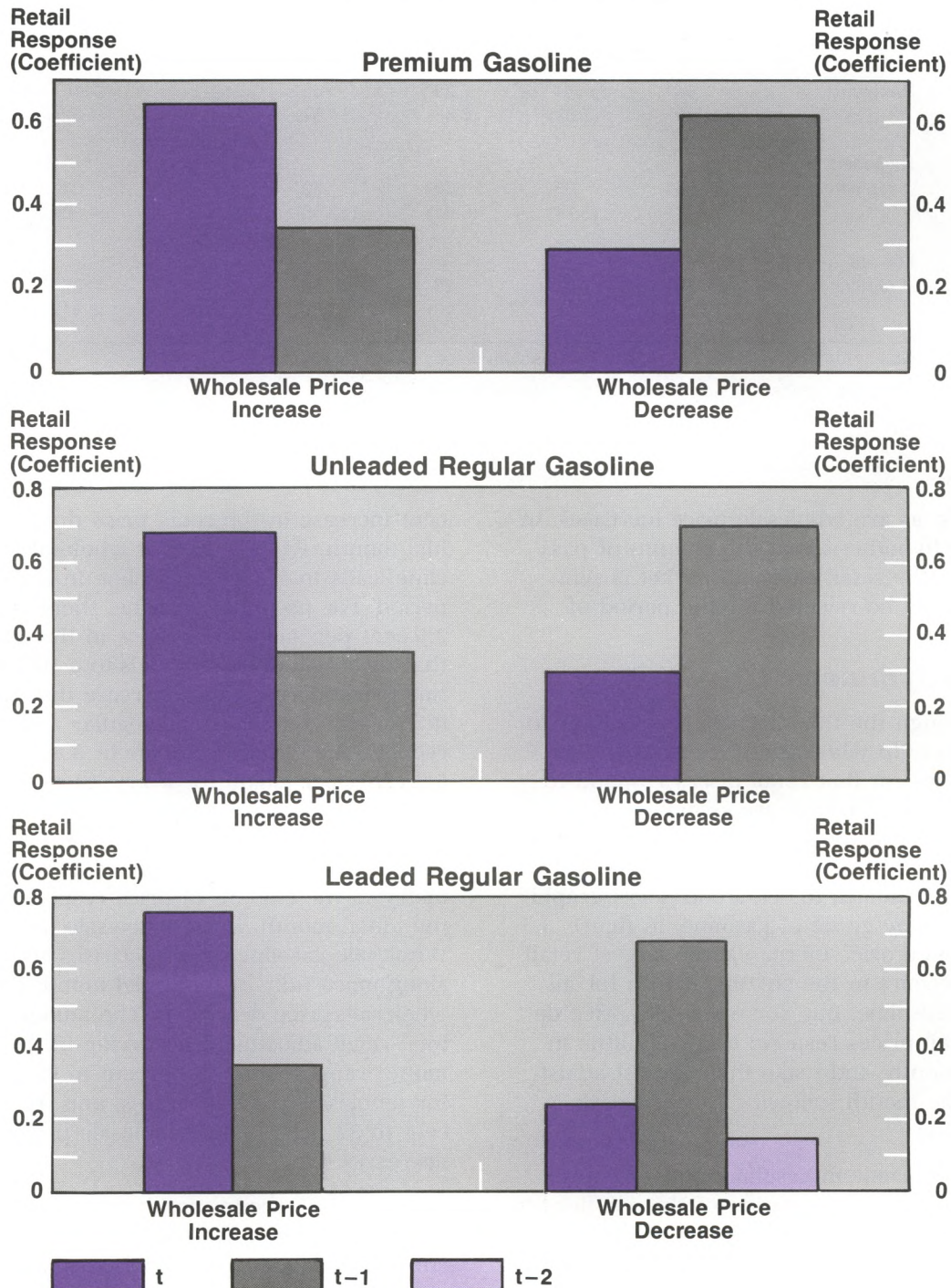
cent increase in the retail price during the initial month, while a 10-cent wholesale price decline leads to a 2.9-cent decline in the initial period. For premium gasoline, there is about a 3.5-cent per gallon difference in the amount that the retail price responds to a 10-cent wholesale price increase and decrease during the initial month. For unleaded regular and leaded regular, the difference is about 3.8 cents and 5.3 cents per gallon for every 10 cent change in the wholesale price, respectively. Indeed, a test for equality of the  $a_{1,0}$  and  $a_{2,0}$  coefficients is rejected for all grades of gasoline, indicating asymmetry in the amount of price response during the initial month of the wholesale price change. Wholesale gasoline price increases are passed along more fully in the initial month than are wholesale price decreases. The amount of the total retail adjustment occurring in the initial month ranges from 65 percent to 69 percent for wholesale price increases, and from 22 percent to 32 percent for wholesale price decreases.<sup>20</sup>

During the second month, between 31 percent and 35 percent of the total retail adjustment occurs for wholesale price increases, and between

<sup>20</sup>The initial month percent response for a wholesale price increase was calculated as  $[a_{1,0}/(\sum_{i=0}^{\infty} |a_{1,i}|)] \times 100$ .



**Figure 3**  
**Asymmetry in the Pattern of Retail Price Response**  
 (Estimated Coefficients for Equation 4)





65 percent and 70 percent for wholesale price decreases. The hypothesis that  $a_{1,1} = a_{2,1}$  is rejected for all grades of gasoline, indicating asymmetry in the amount of price response during the month following a wholesale price change. For leaded gasoline, a third month is needed before the impact of a wholesale price decline is fully reflected in the retail price.

## CONCLUSION

This paper has tested for symmetric retail gasoline price responses to changes in wholesale gasoline prices. The results show that the length of time in which a wholesale price increase is fully reflected in the retail gasoline price is the same as that of a wholesale price decrease for premium and unleaded regular gasoline. Wholesale gasoline price increases for leaded regular gasoline are passed along to the consumer more quickly than price decreases. Although the time in which retail prices fully respond to increases and decreases in wholesale prices is the same for both premium and unleaded gasoline, the pattern of retail price adjustment is such that consumers will experience the bulk of a wholesale price change sooner for price increases than they do for decreases. However, contrary to the popular belief that consumers do not benefit from wholesale gasoline price decreases, wholesale gasoline price decreases are eventually passed along to consumers as fully as are wholesale gasoline price increases.

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# **Monetary Policy and the Farm/Nonfarm Price Ratio: A Comparison of Effects in Alternative Models**

**S**INCE 1974, FOLLOWING PUBLICATION of Schuh's "The Macroeconomics of Agriculture," much research effort has been devoted to determining whether and how monetary policy affects the farm sector. One of the more active areas of interest has been the question of whether changes in the money stock affect the farm/nonfarm product relative price ratio. The reason for this particular interest, as described by Tweeten (1980), is that declines in the relative price ratio represent a "cost-price squeeze" for farmers; thus, he suggests, if contractionary monetary policy causes farm prices to adjust downward more quickly than farm input prices, farm income will decline as well. Penson and Gardner (1988), surveying the relevant literature, conclude that the agricultural sector has borne the brunt of adjustment costs whenever slower money growth has occurred.

These conclusions received considerable attention in policy discussions during the mid-1980s when real farm incomes, exports and asset values were falling sharply. As those discussions intensified, additional research reported that the quantitative effect of monetary actions on relative farm prices was not only large but persistent, if not permanent.

Among recent studies, Devadoss and Meyers (1987), for example, report that negative money supply shocks . . . "harm farmers because farm product prices decrease relatively more than nonfarm product prices" (p. 842). Many other studies found similar results.<sup>1</sup>

In sum, the notion that contractionary monetary policy affects agricultural prices and income differently than comparable measures in the nonfarm sector has become one of the

<sup>1</sup>Chambers (1984); Starleaf, Meyers and Womack (1985); Falk, Devadoss and Meyers (1986); Taylor and Spriggs (1989); and Tegene (1990) found similar results. Doo Bong Han, Jansen and Penson (1990) reaffirm the significance of this linkage by reporting that the conditional means and variances of agricultural prices are more closely related to

the conditional means and variances of M1 than those of industrial prices. Orden (1986a), Lapp (1990), Gardner (1981) and Grennes and Lapp (1986), in contrast, did not find the relative price of farm products to be related to nominal macroeconomic variables.



stylized facts" of agricultural economics.<sup>2</sup> Because neoclassical theory implies that changes in money growth have no real consequences in the long run, however, the large and sometimes permanent effects of monetary actions on agricultural prices reported in the literature seem to present an anomaly. Recent episodes, moreover, seem to run counter to the view that contractionary monetary policy selectively hurts farmers. First, real farm income rose during the late 1980s, a period some analysts would characterize as one of substantial monetary contraction.<sup>3</sup> Second, although the dollar's decline since early 1985 would help expand U.S. farm exports, all other things the same, the exchange rate depreciation has occurred at an odd time: when monetary policy has been contractionary and federal budget deficits have been expanding. Although the conventional wisdom links both factors to lower farm sector prices and income, this result is supposed to be transmitted through a *rising* value of the dollar.<sup>4</sup>

This article reviews the previous literature linking monetary actions to the relative price of farm products and attempts to reconcile the conflicting theoretical and empirical approaches that have been applied to this issue. Because previous studies derive their empirical models from a variety of generally noncomparable theoretical models, this paper highlights cases in which the direction or significance of a particular variable's impact differs across models. By estimating each model with the same data and testing each model's implications directly, we can better assess monetary policy's effects on relative farm prices and the agricultural sector.

## A REVIEW OF THE LITERATURE

Table 1 lists the important features of studies that examined the effects of monetary actions on the farm/nonfarm relative price ratio. The most common measure of farm prices used in these studies is the index of prices received by farmers. The relative price issue is typically in-

vestigated by dividing this index by another index of either the aggregate price level or the prices of some commodity bundle composed of nonfarm products; in some instances, farm and nonfarm nominal price indexes have been regressed on a monetary measure individually to identify different speeds of adjustment and thereby infer the net impact of changes in money growth on the selected relative price ratio. M1 has been used almost uniformly as the indicator of monetary actions.

Annual, quarterly and monthly data have been used to estimate the empirical relationship between M1 and the relative price measure. Most studies specify this relationship as one between the natural logarithms of the two series, something which, in view of the more recent literature on common trends in data and spurious regression relationships, may have given rise to significant associations where none actually existed.<sup>5</sup>

With the exceptions of Lapp (1990), and Grennes and Lapp (1986), these studies found M1 to have short-run effects on the farm/nonfarm relative price ratio. Unfortunately, in many cases, it is not easy to categorize the significance, magnitude or persistence of these effects. Where tested, the verdict seems about evenly split between those studies that find monetary actions to be neutral in their effect on the long-run relative price ratio and those that find the effects to be permanent. The only general conclusion that emerges from the studies summarized in table 1 is that the wide diversity among sample periods, relative price measures, variable specifications and results makes it difficult to tell whether and by how much monetary actions affect the farm/nonfarm relative price ratio.

## A REVIEW OF THE DATA

Figure 1 shows quarterly values for the annualized percentage changes in the indexes of prices received and prices paid by farmers since 1976.<sup>6</sup> These indexes are based on the bundle

<sup>2</sup>Chambers (1985).

<sup>3</sup>Between IV/1986 and IV/1990, for example, the 12-quarter moving average growth rate of M1 declined from 10.3 percent to 3.0 percent. A "trend" growth rate of M1 this low has not been seen in nearly three decades.

<sup>4</sup>See, for example, Belongia and Stone (1985).

<sup>5</sup>See, for example, Granger and Newbold (1974), Plosser and Schwert (1978) and Dickey and Fuller (1979, 1981).

<sup>6</sup>Use of monthly data or producer price indexes for farm and industrial (nonfarm) commodities does not affect the

qualitative conclusions of this section. The plot starts in 1976 to avoid the price volatility associated both with OPEC and U.S. farm policies in the 1973-74 period. Moreover, the empirical work to follow begins after the system of flexible exchange rates was adopted and most of the one-time adjustments to new exchange rate levels—especially trade flows—are presumed to have taken place.



Table 1

# A Summary of Results from Studies of the Monetary Policy-Relative Farm Price Question

Author(s)	Relative price measure	Monetary policy indicator	Sample period	Data frequency	Specification of variables	Long-run neutrality of money
<b>"Important" Monetary Effects</b>						
Chambers (1984)	CPI-food CPI-nonfood	M1	1976.05-1982.05	Monthly	Logs	Not tested
Starleaf, et al. (1985)	Prices received, Prices paid	Inflation rate	1930-83; 1930-53; 1954-70; 1971-83	Annual	Percentage changes	Not tested
Devadoss and Meyers (1987)	Prices received Index of Industrial Product Prices	M1	1960.01-1985.12	Monthly	Logs	Non-neutral
Taylor and Spriggs (1989)	Index of Canadian Farm Product Prices	M1 (Canada)	1959.1-1984.4	Quarterly	$\Delta$ Logs	M1 had largest effect of <i>domestic</i> variables, but all foreign variables had larger effects.
Tegene (1990)	PPI farm output, PPI nonfarm output	M1	1934-87	Annual	Logs	In the short run, a change in M1 affects farm prices more quickly than manufacturing prices.
Han, et al. (1990)	Index of Farm Prices	M1	1960.1-1985.4	Quarterly	$\Delta$ Logs	Conditional mean and variance of farm prices are more sensitive to changes in M1 than are the conditional mean and variance of industrial prices.
<b>"Small" Monetary Effects</b>						
Grennes and Lapp (1986)	Prices received CPI	M1	1951-81	Annual	Logs; $\Delta$ logs	Neutral
Lapp (1990)	Prices received PPI or CPI	M1	1951-85	Quarterly	$\Delta$ Logs	Neutral
<b>Importance of Monetary Effects is Subject to Interpretation</b>						
Orden (1986)	Prices received GNP deflator	M1; Interest rates	1960.1-1984.3	Quarterly	Logs	Monetary effects are small if represented by M1, but larger if represented by interest rates.
Orden and Fackler (1989)	Prices received GNP deflator	M1; Interest rates	1975.1-1988.1	Quarterly	Logs	Small, but significant, effect over four quarter period; long-run neutrality.
Robertson and Orden (1990)	New Zealand farm output prices, Manufacturing prices	New Zealand M1	1963.1-1987.1	Quarterly	Logs	Clear short-run effect over four quarters; long-run neutrality holds.

of farm products that farmers produce and sell and commodities that farmers purchase as production inputs, respectively.<sup>7</sup> Quarterly values for the growth rate of M1 also are shown in this figure. Data for the individual series are summarized in table 2. As the figure and table show, farm product prices have been more vol-

atile than farm input prices. A test of the equality of variances, for example, produces an F-statistic of 7.62 against a 5 percent critical value of 1.53.

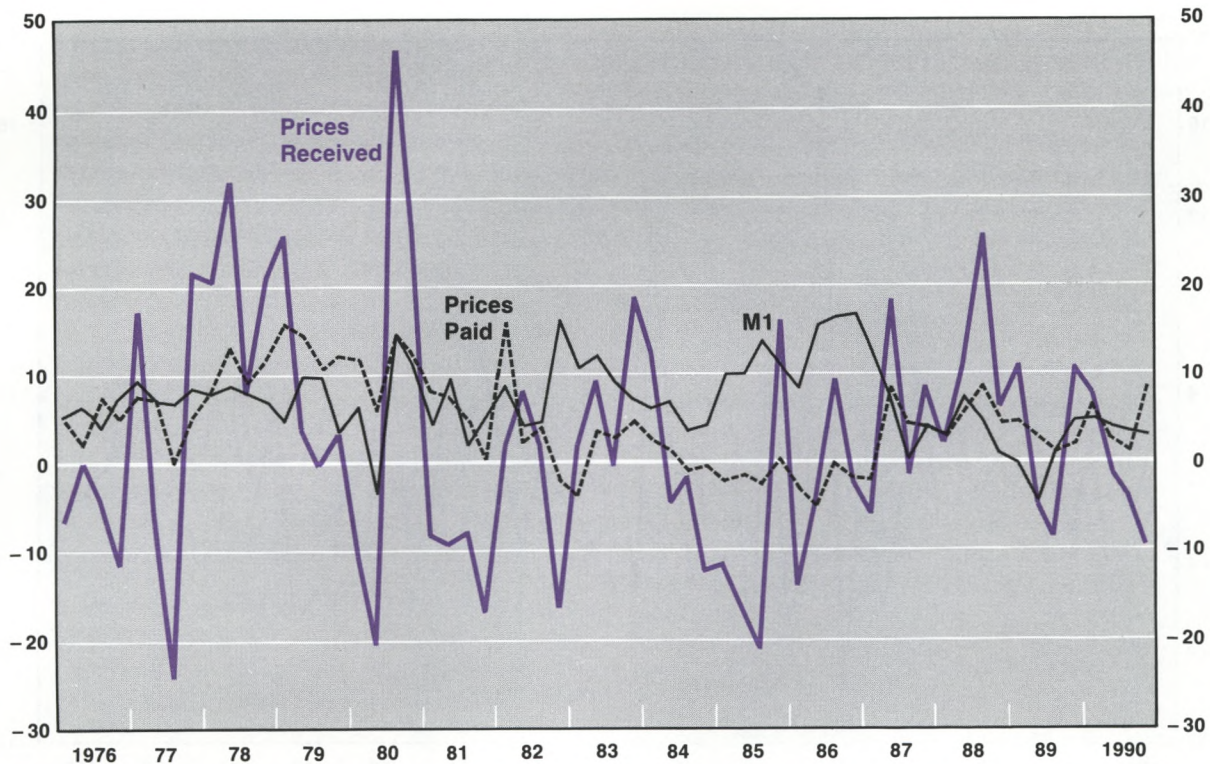
Figure 2 shows changes in the ratio of the indexes plotted against changes in M1 growth. In

<sup>7</sup>The prices received measure is a weighted index of about 112 farm product prices; the prices paid measure is a weighted index of about 450 farm input prices. For more

detail, see Handbook #365, U.S. Department of Agriculture (1970).



**Figure 1**  
**Growth of M1, Prices Paid by Farmers, and**  
**Prices Received by Farmers**



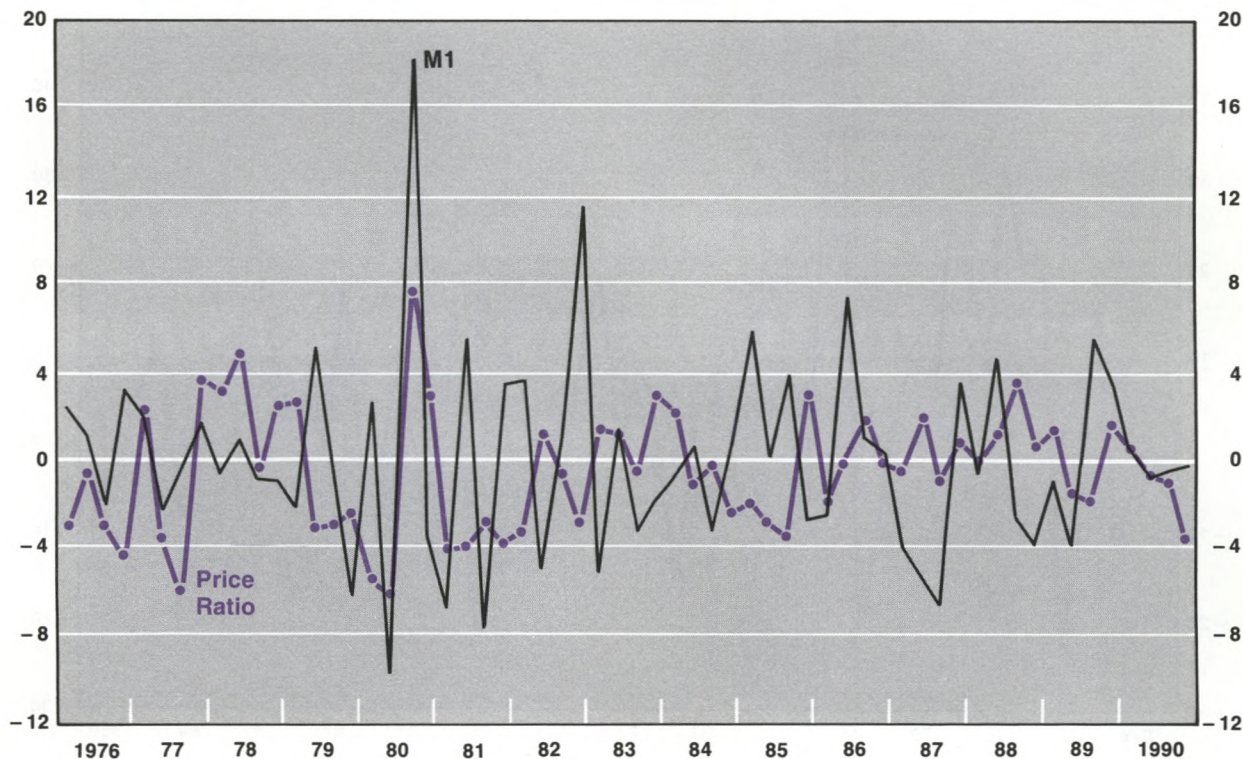
**Table 2**

**Descriptive Statistics for Farm and Nonfarm Prices,**  
**I/1976-IV/1990 (annualized first differences of logarithms,**  
**quarterly data)**

	<u>Mean</u>	<u>Standard deviation</u>	<u>Minimum</u>	<u>Maximum</u>
Prices received by farmers	2.22%	14.30%	-24.75%	46.74%
Prices paid by farmers	4.74	5.18	-4.96	15.92
Prices received/prices paid	-2.52	12.38	-26.35	32.18
M1	7.03	4.49	-4.09	16.85



**Figure 2**  
**First Difference of the Ratio of Prices Received to Prices Paid and the Change in M1 Growth**



very simple terms, these series represent the logic in much of the literature that links monetary policy to the relative price of farm products. For example, accelerations in money growth are thought to be associated with increases in the farm/nonfarm product price ratio. Over this sample period, however, the simple correlation coefficient for these series, 0.13, is not significantly different from zero at the 5 percent significance level.

Finally, it is interesting to abstract from the short-run volatility in these series and examine the data for longer-run trends. Since 1976, the average growth rate of prices received by farmers has been about one-half that of farm input prices; as a consequence, the relative farm price ratio has fallen at an annual rate of more than

2.5 percent. Conversely, M1 has grown over the sample period at an annual average rate of 7.03 percent. From a long-run perspective, the downward trend in the relative price ratio is consistent with what Tweeten has called a "cost-price squeeze" for farmers. The origin of this squeeze, however, does not seem to be related to the relatively expansionary long-run course of monetary policy.<sup>8</sup>

### **MONEY GROWTH AND RELATIVE PRICES: ALTERNATIVE THEORETICAL RESULTS**

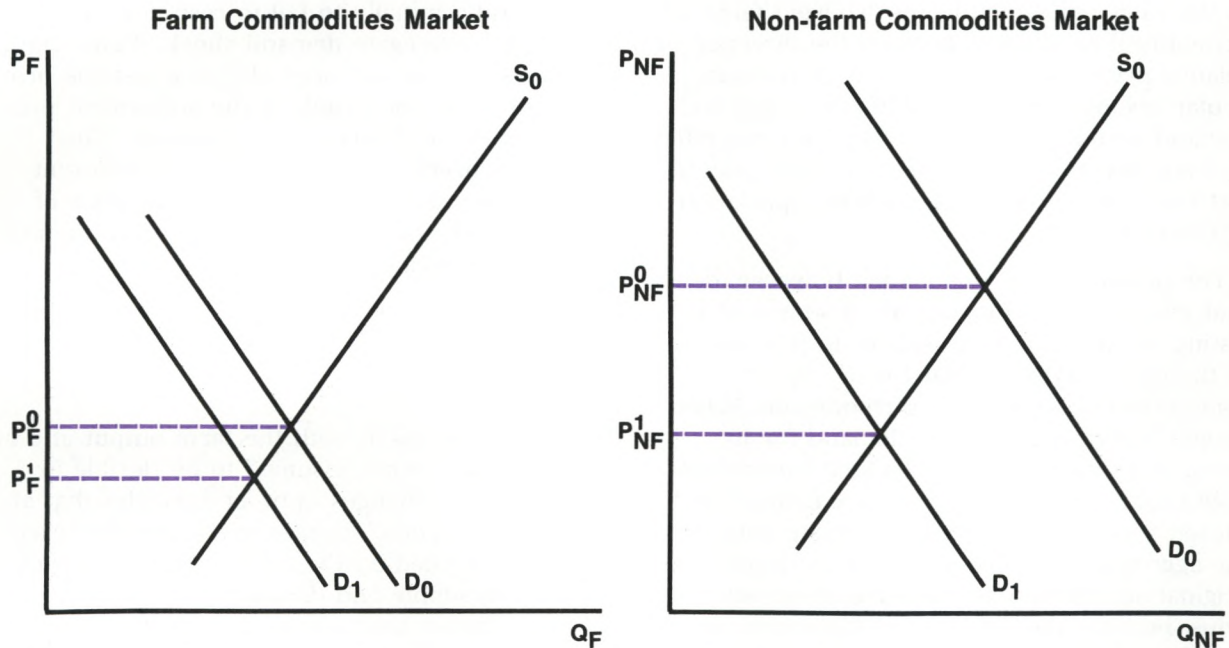
The research attempting to link monetary actions to relative farm price changes has not questioned *whether* changes in money growth

<sup>8</sup>See Meltzer (1990) for a thorough review of U.S. monetary policy since the mid-1960s, with special emphasis on its tendency to produce increasing rates of money growth.



**Figure 3**  
**Graphical Representation of a Barro-type Model**

MODEL I.



**Model Assumptions and Predicted Result:** An unanticipated decrease in money growth causes the demands for both farm and nonfarm commodities to fall. Because the income elasticity of farm commodity demand is assumed to be lower than that for nonfarm products, the decrease in farm product demand is smaller. Assuming identical supply elasticities in the two markets,  $\Delta P_F < \Delta P_{NF}$  and  $(P_F/P_{NF})$  rises.

affect the farm/nonfarm price ratio; instead, the direction, size and persistence of this effect have been its primary focus. Because alternative theoretical models produce different empirical specifications and, quite possibly, different results, some attempt must be made to distinguish among these alternatives. For guidance on these issues, the testable implications of three models used to investigate the money-relative price question are developed below.

### **Model 1: A Change in Money Growth as a Shock to Aggregate Demand**

Equilibrium "Barro-type" models assume that anticipated changes in the money stock affect

all nominal prices equi-proportionally and therefore leave relative prices unchanged.<sup>9</sup> Relative prices are affected in these models only by an *unexpected* change in the money stock. In model #1, illustrated in figure 3, an unanticipated decline in the money stock produces a negative shock to aggregate demand as people find themselves with a shortage of real money balances and an excess supply of goods. Their collective actions to restore equilibrium by reduced spending shifts aggregate demand to the left. This shift lowers output and income temporarily and the price level permanently.

If supply elasticities in the farm and nonfarm sectors are identical, this demand shift will affect relative prices only if the income elasticities

<sup>9</sup>See, for example, Barro (1976).



of demand for farm and nonfarm products differ. If the income elasticity for farm products is lower than that for nonfarm products, an unexpected decrease in the money stock would *increase* temporarily the relative price of farm products.<sup>10</sup> This interpretation of the model, therefore, predicts a response that is contrary to the story embedded in the "stylized facts" of agricultural economics. Because the direction of relative price change will vary with the particular assumptions about shifts in supply and demand across markets, the "sign" on this effect in a regression equation offers a direct way to test the implications of this one interpretation of the model.

The predictions of this model, however, deny that monetary contractions are a source of long-lasting harm to the farm sector. In this case, as in the other examples that follow, the real income effect is a short-run phenomenon. When people realize that the real demand for individual products has not changed fundamentally but that, instead, the monetary contraction caused a general decline in aggregate demand, the aggregate price level will fall to restore the original equilibrium and relative price ratio. Thus, because the decrease in the money stock is reflected only in a lower aggregate price level in the long run, the neutrality of monetary actions is preserved. In this model, as well as in model #2 that follows, whether the relative price ratio rises or falls and whether it returns to its original value in the long run are the model's testable hypotheses. As shown in table 1, however, the long-run neutrality proposition has not been tested in many previous studies or, when violated, often has not been discussed.<sup>11</sup>

### ***Model 2: Relative Price Changes Caused by Different Elasticities of Supply***

A slightly different variant of the equilibrium Barro model, which predicts a relative price change in the opposite direction from the previous discussion, is based on different assumptions about the structure of the farm and nonfarm goods markets. In this model, illustrated in figure 4, the short-run elasticity of supply of farm products is argued to be less than that of

nonfarm products because of differences in the production processes.<sup>12</sup> With long lags between planting and breeding decisions and product marketings, the ability to adjust farm output in the short run is assumed to be limited. Other things the same, this characteristic of farm production would cause the farm/nonfarm relative price ratio initially to fall in response to a negative aggregate demand shock. Again, the existence of long-run neutrality is a testable proposition and the length of the adjustment process must be determined empirically. This model's predictions, however, are consistent with the argument that the relative price of farm products will fall under a contractionary monetary policy.

### ***Model 3: Price Stickiness and "Overshooting"***

So far, prices in both the farm output and input markets were assumed to be flexible in response to changes in other variables that affect them. Thus, changes in the relative price ratio depended on the relative magnitudes of shifts in supply and demand and the slopes of those curves; they were not influenced by different speeds of adjustment in the two markets. Another approach to this question has relied on some degree of price-stickiness in nonfarm prices to explain changes in the relative price ratio.

By adapting the overshooting model from the exchange rate literature, as illustrated in figure 5, this analysis assumes that prices in the flexible price (farm) sector adjust to a monetary change more quickly than other prices in the fixed price (nonfarm) sector.<sup>13</sup> So, for example, while long-term contracts prevent nonfarm prices from adjusting downward immediately in response to a monetary contraction (as they would in the Barro-type model), the auction market characteristics of the determination of farm prices force them to fall quickly and, consequently, temporarily reduce the farm/nonfarm relative price ratio as well. Thus, again in the short run, a negative monetary change causes a temporary reduction in farm prices relative to nonfarm prices.

<sup>10</sup>Historically, this assumption has been supported by the data with estimates of the income elasticity for food demand near 0.2 and higher estimates for nonfood items; see King (1979) for a review of this literature.

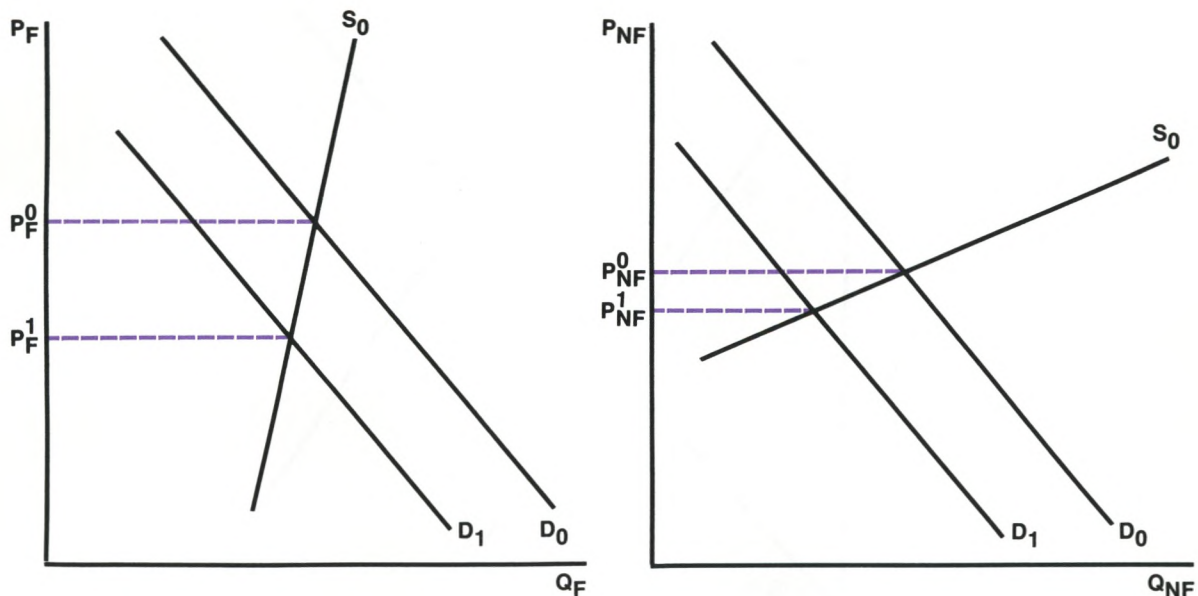
<sup>11</sup>Exceptions are Bessler (1984) and Robertson and Orden (1990).

<sup>12</sup>See, for example, Starleaf (1982).

<sup>13</sup>See, for example, Frankel (1986) or Rausser (1985).



**Figure 4**  
**Graphical Representation of Differing Supply Elasticities Model**



As in Model I, an unanticipated decrease in money growth decreases the demands both for farm and nonfarm products; here, however, the decreases are assumed to be equal. Under these conditions, a lower elasticity of supply for farm products will cause  $\Delta P_F > \Delta P_{NF}$  and  $(P_F/P_{NF})$  will fall. Note that combining the results of Model I with Model II produces an ambiguous result because differences in the sizes of demand shifts may be large enough to cause an increase, a decrease, or no change in  $(P_F/P_{NF})$ .

Although this predicted direction of relative price change is the same as in model #2, the mechanics of price stickiness allows the possibility that fully anticipated monetary changes (as well as unexpected changes) can affect the relative price ratio. Thus, testing for the significance of expected monetary changes on the relative price ratio provides a direct way to discriminate between the two models. Unfortunately, the converse is not true: failing to find significant effects from anticipated monetary changes does not necessarily reject an overshooting type of model because its mechanics can be set in motion solely by monetary surprises as in the previous cases.

### RECONCILING ALTERNATIVE THEORIES

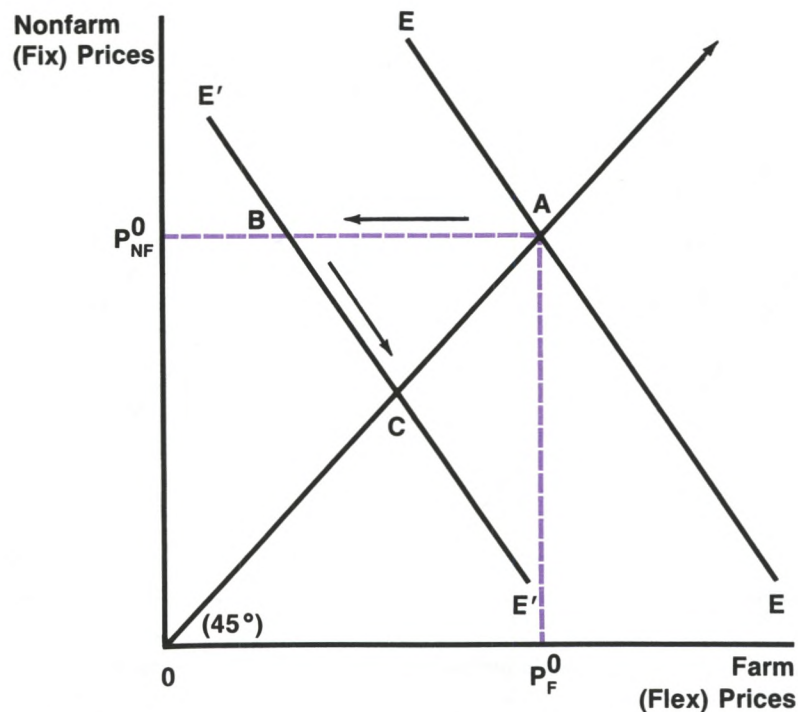
The foregoing discussion showed that farm prices are significantly more variable than non-

farm prices, and that the farm/nonfarm relative price ratio has declined persistently over time. Unfortunately, the implications of our three models differed considerably in terms of the expected direction of change in the relative price of farm products to nonfarm products as well as the mechanism by which a monetary action influenced this ratio. To resolve this conundrum, each model was estimated using identical data sets to see which one's implications are best supported by the results.

These estimations are intended to provide evidence on three aspects of the possible monetary influences on the farm/nonfarm relative price ratio. The first piece of evidence is the *direction* of relative price change; this will discriminate between model #1 vs. models #2 and #3. The second piece of evidence is the *statistical significance* of the relationship, where the significance of a variable can be viewed as evidence for or against a particular model. The



Figure 5  
The Overshooting Model<sup>1</sup>



Schedule EE shows all possible equilibrium relationships between  $P_F$  and  $P_{NF}$  prior to the change in monetary policy. Slower money growth, which is disinflationary, shifts EE to  $E'E'$  where farm (flex) prices ( $P_F$ ) decrease but nonfarm (fix) prices ( $P_{NF}$ ) do not adjust; thus,  $P_F$  “overshoots” from point A to point B. As fix-price markets adjust,  $(P_F/P_{NF})$  gradually returns to the long-run equilibrium at point C.

<sup>1</sup>Adopted from R. Dornbusch, *Open Economy Macroeconomics*, Fig. 11-8, p. 208.

third piece of evidence is the *magnitude* of the impact that a given monetary change has on the relative price ratio; here, it is recognized that monetary effects may be statistically significant and yet still be quantitatively unimportant.

### VAR Estimation

As a first step in the investigation, a vector autoregressive (VAR) model was estimated. A VAR, which can be used to determine the

amount of variation in the relative price ratio that one might attribute to monetary shocks, is useful in gauging the strength of the hypothesized relationship. It has the additional advantage of not requiring the specification of any particular functional form among the variables included in the model. The VAR and other equations that follow were estimated with quarterly, seasonally adjusted data over the I/1976-IV/1990 sample interval. Thus, by way of in-



**Table 3**  
**Single-Equation Results for the VAR Estimation, I/1976-IV/1990**

Dependent variable	Explanatory Variables					
	Relative prices	M1	Exchange rate	Industrial production	$\bar{R}^2$	DW
Relative price	0.206 (1.089)	0.031 (0.064)	-0.233 (1.735)	-0.147 (0.413)	.12	1.98
M1	0.015 (0.257)	0.626 (4.192)	-0.020 (0.488)	-0.257 (2.340)	.28	1.96
Exchange rate	0.451 (1.874)	-0.046 (0.075)	0.499 (2.929)	-0.137 (0.302)	.09	2.04
Industrial production	0.131 (1.690)	0.344 (1.737)	0.003 (0.063)	0.515 (3.541)	.29	2.01

NOTE: t-statistics in parentheses apply to sums of lag coefficients and apply to the null hypothesis that the sum is equal to zero.

roduction to the more specific testing to follow, the VAR can offer some insights to the strength of the money-relative price link.

The VAR model included four variables: the farm/nonfarm price ratio (as measured by the ratio of the indexes of prices received by farmers to the producer price index), M1, the index of industrial production and the real trade-weighted exchange rate. Variables other than M1 were included because observed changes in the relative price ratio may have other origins. For example, technological changes in the non-farm sector (which would affect industrial prices) or export demand (which could have varying effects across the farm and nonfarm sectors) could affect the relative price ratio in isolation from monetary changes.<sup>14</sup> While these other measures do not exhaust the list of in-

fluences on the relative price ratio, they do capture other influences affecting prices in the farm and nonfarm product markets so that the remaining variation can be explained by changes in M1 growth and the past history of the relative price ratio itself. These variables also were chosen because they have been used in previous work and our interest is in stressing comparability with other studies. All variables were specified as first differences of logarithms.<sup>15</sup>

Sums of lagged coefficients and t-statistics for these sums for the single equation estimation are reported in table 3. The results of interest indicate that M1 growth is not related significantly to changes in the relative price of farm products.<sup>16</sup> One possible explanation for this result is that flows from farm inventories, which were historically large over most of the sample

<sup>14</sup>Evaluating the impact of the industrial production measure here also will serve as an additional check on the overshooting model, which includes an output measure as an explanatory variable and predicts a positive relationship with the relative price ratio.

<sup>15</sup>A likelihood ratio test suggested by Sims (1980) was employed to select a single lag length for all variables in each of the four equations in the VAR representation. This test indicated a choice of two quarters.

<sup>16</sup>The estimations reported in tables 3 and 4 also were performed using relative price measures defined as the index

of prices received by farmers divided by either the index of input prices paid by farmers or the all-item CPI. The possible effects of exports on relative prices also was investigated by replacing the real exchange rate index with the real quantity of U.S. farm exports. In no case, however, were the qualitative conclusions discussed in the text affected by this change: M1 growth never had a significant effect on the relative price ratio and the effects of trade flows were significant only if significance levels beyond the standard 5 percent level were used.



Table 4

**VAR Variance Decomposition: Four-, Eight- and 12-Quarter-Ahead Forecast Error Variances**

Dependent variable	Innovations Series			
	Relative prices	M1	Exchange rate	Industrial production
Relative price	81.62	0.72	8.11	9.54
	81.28	0.93	8.15	9.64
	81.28	0.93	8.15	9.65
M1	5.42	79.14	2.81	12.63
	6.87	76.11	2.75	14.27
	6.90	76.04	2.75	14.30
Exchange rate	6.30	7.14	84.78	1.79
	6.47	7.33	84.24	1.96
	6.48	7.33	84.20	1.98
Industrial production	29.59	13.51	2.75	54.16
	28.92	15.10	3.05	52.93
	28.93	15.12	3.05	52.91

NOTE: Row 1 = Four-quarter-ahead forecast error  
 Row 2 = Eight-quarter-ahead forecast error  
 Row 3 = 12-quarter-ahead forecast error

period, offset any relative price change caused by an aggregate shock.

Only the real exchange rate, which has a marginally significant and negative coefficient, is statistically associated with the relative price ratio. While this result is consistent with many of the arguments raised by agricultural economists about how restrictive monetary policy could raise the exchange rate, reduce exports and depress farm prices, this line of reasoning is not shown by line 3 of table 3, which indicates no statistically significant relationship between M1 and the real exchange rate. Thus, these reduced-form estimates suggest that monetary changes have little, if any, effect on the relative price ratio.

### **Variance Decomposition**

Further evidence about the effect of monetary shocks on relative prices is found in table 4, which presents the percentage of four-, eight-

and 12-quarter-ahead forecast error variances explained by past innovations in the relative price ratio and the other variables in the model.<sup>17</sup>

Monetary shocks explain less than 1 percent of the relative price forecast error variance, while about 81 percent is attributable to past innovations in the relative price series itself. These findings are generally consistent with those reported by Chambers (1984) and Orden (1986b), who found less than 10 percent of the error variance could be attributed to monetary shocks and more than half could be attributed to past behavior of the relative price ratio.<sup>18</sup> Moreover, both the real exchange rate and industrial production explain substantially more of the variation in the relative price ratio than does M1.

As noted earlier, other analysts (most notably Schuh) have argued monetary effects are trans-

<sup>17</sup>Because VAR results are sensitive to the ordering of variables [e.g., Cooley and LeRoy(1985)], the table contains the results from the ordering that gives the largest potential influence for M1.

<sup>18</sup>Devadoss and Meyers (1987), who reported large and quite persistent monetary effects on relative prices, did not report a variance decomposition, so their results are not directly comparable.



mitted to agriculture *through the real exchange rate* and its impact on farm exports. Some insight into this notion is found in table 4, which shows that innovations in the real exchange rate series account for about 8 percent of the variance in relative farm prices. Moreover, monetary shocks apparently explain only about 7 percent of the variance in real exchange rate movements, a result consistent with the small or non-significant effects of monetary shocks on the real exchange rate reported by Batten and Belongia (1986). Thus, all things and potential avenues of influence considered, these results indicate a statistically weak and numerically small relationship between monetary shocks and movements in the farm/nonfarm price ratio. The shaded insert on page 42 discusses possible changes in these relationships if the thrust of monetary policy is measured by different indicators.

### ***Estimates From a Barro-Type Model***

While the foregoing results suggest a fairly weak relationship between monetary shocks and relative price changes, the VAR method is not appropriate for testing the relevant structural hypotheses that characterize the models discussed above. In a model that treats a monetary shock as a shock to aggregate demand, assuming a lower income elasticity for farm products would imply that, in the short run, the farm/nonfarm relative price ratio is inversely related to innovations in M1. Moreover, because neoclassical models of this nature recognize that nominal shocks affect real or relative magnitudes only in the short run, the sum of the coefficients for lagged innovations in M1 should not be significantly different from zero. The persistence of any short-run nonneutralities, however, remains to be determined.

The basic predictions of this model can be examined by estimating an equation of the form:

$$(1) \Delta \left( \frac{P_F}{P_{NF}} \right) = a + \sum_{i=0}^p b_i E(\dot{m})_{t-i} + \sum_{j=0}^q c_j [\dot{m} - E(\dot{m})]_{t-j} + \varepsilon_{1t}$$

where  $E(\dot{m})$  is the expected growth rate of M1,  $[\dot{m} - E(\dot{m})]$  is the unexpected component of M1

growth, and  $a$ ,  $b_i$  and  $c_j$  are coefficients to be estimated over undetermined lag lengths  $p$  and  $q$ , respectively. Under the assumptions about market structure discussed earlier, the  $b_i$  coefficients should be zero and the  $c_j$  coefficients for the initial lags of unexpected changes in money growth should take negative values; the model's general prediction about the long-run neutrality of monetary shocks implies that the sum of  $c_j$  coefficients should be zero. Lapp (1990), who recently discussed and reported results from a model of this form, found monetary actions to have small, short-lived effects on the relative price ratio.<sup>19</sup>

Before equation 1 can be estimated, the requisite values for the aggregate demand shock (the unexpected component of M1 growth) must be obtained. An autoregressive model was fit to the first differences of logarithms of M1 and inspection of the autocorrelation functions indicated an AR(6) was an adequate representation of this series. The null hypothesis that the residuals from this representation were white noise could not be rejected. These residuals were employed in equation 1 as the measure of monetary shocks; the fitted values were used to represent anticipated money growth.

A final prediction error (FPE) criterion suggested estimating a model with contemporaneous and three lagged values for the unanticipated component of money growth and excluding the anticipated portion of money growth entirely. Before estimating equation 1 in this form, it first was estimated using contemporaneous and three lagged values for both monetary variables in order to test more directly whether anticipated money growth had any effect on relative prices. As the first row of table 5 indicates, neither component of money growth is related significantly to the farm/nonfarm product ratio. The second row of the table, which reports the results of the model chosen by the FPE criterion, shows that monetary shocks have no permanent effects on the relative price ratio. Moreover, none of the individual lag coefficients (not reported) is significantly different from zero indicating the

<sup>19</sup>Equation 1, in many respects, is the one Devadoss and Meyers (1987), among others, estimated after placing zero restrictions on the  $b_i$  coefficients. If, however, their results are explained by a fix-price/flex-price (overshooting) economic structure, fully anticipated changes in the money stock could affect the relative price ratio and there is no justification for the restrictions (see equations 2 and 3

below); rather, the significance of those coefficients is a key hypothesis to be tested. Moreover, by failing to specify a theoretical model, Devadoss and Meyers also miss the chance to rule out a Barro-type model as an explanation for relative price behavior on the basis of "wrong" (positive) signs for the  $c_j$  coefficients.



# Is M1 The "Right" Measure Of Monetary Actions?

Investigations of how monetary actions affect economic activity have been influenced in the 1980s by financial deregulation and innovation. Most notable among these financial changes was the introduction of interest-bearing checkable deposits, which, many economists believe, has distorted the behavior of M1 since 1981.<sup>1</sup> Other research has argued that another measure of Federal Reserve actions—the federal funds rate—is more closely related to economic activity than money growth; indeed, Orden and Fackler (1989), in a similar study of monetary actions and the relative price of farm products, speculate about whether interest rates are a better gauge of monetary actions than money growth.<sup>2</sup>

To investigate these issues, the analysis reported in tables 3 and 4 was repeated replacing M1 growth with the growth rate of M1A and the first difference of the federal funds rate. M1A, which is M1 less interest-bearing checkable deposits, presumably deletes idle savings-type balances from what is intended to be a transactions-based measure of the money stock. Indeed, Darby, et al. (1989) found M1A to be a better empirical measure of monetary actions in the 1980s than M1. Using the federal funds rate can be defended by arguing that it examines the influence of an interest rate that is directly under the control of the Federal Reserve. The relevant results of these estimations are reported in the table below.<sup>3</sup>

## Revised VAR Estimates Using M1A and the Federal Funds Rate As Monetary Indicators: I/1976-IV/1990

Revised Reduced-Form Estimates						
Dependent variable	Relative price	Monetary indicator	Exchange rate	Industrial production	$\bar{R}^2$	DW
Relative price	0.215 (1.124)	0.019 <sup>1</sup> (0.036)	-0.237 (1.488)	-0.167 (0.471)	.12	1.97
Relative price	0.213 (1.148)	-2.718 <sup>2</sup> (1.404)	-0.210 (1.694)	0.034 (0.091)	.15	1.96
Revised Variance Decompositions						
Dependent variable	Relative price	Monetary indicator	Exchange rate	Industrial production	Forecast horizon	
Relative price	81.70	1.48 <sup>1</sup>	7.53	9.29	4 Qtr.	
	81.05	2.21	7.47	9.27	8 Qtr.	
	81.04	2.21	7.47	9.27	12 Qtr.	
Relative price	78.19	8.94 <sup>2</sup>	3.60	9.28	4 Qtr.	
	77.81	9.09	3.62	9.47	8 Qtr.	
	77.81	9.09	3.62	9.47	12 Qtr.	

<sup>1</sup>Monetary indicator is  $\Delta \ln M1A$ .

<sup>2</sup>Monetary indicator is  $\Delta$  fed funds rate.

<sup>1</sup>See, for example, Belongia and Chalfant (1990) for a review of some of the issues.

<sup>2</sup>See Friedman and Kuttner (1990) for arguments and evidence on the federal funds rate as an indicator of monetary policy.

<sup>3</sup>Complete results are available from the author.



The top portion of the table, which reports the revised reduced-form equations using the growth rate of M1A and changes in the federal funds rate as monetary indicators, shows no qualitative change to the results in table 3: neither indicator of monetary actions is related significantly to movements in the

relative price ratio. Similarly, the bottom portion of the table indicates that neither monetary indicator explains more than 10 percent of the forecast error variance and that movements in the relative price ratio continue to be dominated by past shocks to the ratio itself.

absence of short-run effects as well. If monetary actions have any effect on the farm/nonfarm price ratio, the results in table 5 reject the notion that they are transmitted through the mechanism described in figure 3.

### *The Overshooting Model*

The implications of the overshooting model, derived in Frankel (1986), can be stated in a straightforward manner. The testable hypotheses implied by the model shown in equation 2 are that a change in the log level of the money stock ( $\Delta m_t$ ) or in the expected growth rate of money ( $\Delta \mu_t$ ) will have larger-than-proportional effects on farm prices. That is, in a regression of the form,

$$(2) \Delta P_{Ft} = c_0 + c_1 \Delta m_t + c_2 \Delta \mu_t + \varepsilon_t,$$

where  $\Delta P_{Ft}$  is the change in the log level of the index of prices received by farmers, the expected results are that  $c_1 > 1$  and  $c_2 > 1$ . Thus, "overshooting" occurs because farm prices respond initially by a larger percentage than either the actual level of the money stock or the expected rate of money growth. The standard interpretation of this model, which

assumes that nonfarm prices are fixed in the short run, also would imply that contractionary monetary policy would temporarily depress the farm/nonfarm relative price ratio, a result opposite to that from model #1.

Finally, some analysts have tried to account for business cycle effects on farm prices by adding the change in the log level of real output ( $\Delta y_t$ ) to equation 2. This gives equation 3:

$$(3) \Delta P_{Ft} = c_0 + c_1 \Delta m_t + c_2 \Delta \mu_t + c_3 \Delta y_t + \varepsilon_t.$$

Note that equation 3 maintains the two original overshooting hypotheses implied by equation 2 ( $c_1 > 1$ ;  $c_2 > 1$ ).

The hypotheses embodied in equations 2 and 3 were tested over the same periods reported earlier. Real output was measured by industrial production. The change in the expected money growth rate,  $\Delta \mu$ , was calculated as the first difference of fitted values from the money growth autoregression discussed earlier. The equations first were fit only with contemporaneous values for right-hand-side variables and then, again, allowing for lags. Results of the estimations are reported in table 6.

**Table 5**

#### **Effects of Monetary Shocks on Relative Prices in a Barro Model**

<u>Intercept</u>	<u>Expected M</u>	<u>Unexpected M</u>	<u><math>\bar{R}^2</math></u>	<u>DW</u>
- 25.862 (1.604)	3.371 (1.473) 0-3	- 2.298 (0.909) 0-3	- .03	1.51
- 2.211 (1.237)	—	0.493 (0.535) 0-3	- .01	1.48

NOTE: The third line of numbers in each row of the table indicates lags estimated. The numbers in parentheses are t-statistics for the sum of the lag coefficients.



**Table 6**  
**Results from Overshooting Models, I/1976-IV/1990**

<u>Intercept</u>	<u><math>\Delta m</math></u>	<u><math>\Delta \mu</math></u>	<u><math>\Delta y</math></u>	<u><math>\bar{R}^2</math></u>	<u>DW</u>
-0.071 (0.20)	0.350 (0.80)	0.381 (0.49)	—	-.01	1.56
-1.662 (0.47)	0.248 (0.59)	0.283 (0.38)	0.793 (2.58)	.08	1.60
5.26 (1.36)	-0.485 (1.01)	0.120 (0.17)	0.685 (1.77)	.23	1.38
	0-1	0	0-1		

NOTE: The third line of numbers in the bottom row of the table indicates lags estimated. Numbers in parentheses for bottom regression are t-statistics for the sums of the lag coefficients.

Although none of the results for the restricted model shows any effects from either monetary variable, the more general form of the overshooting model indicates a significant contemporaneous relationship between the growth rate of industrial production and index of prices received by farmers; the sum of this effect and the coefficient for the lagged effect, however, is not significantly different from zero.

The crucial question for the overshooting model, however, is whether the coefficients associated with the growth rate of M1 and the change in the expected growth rate of M1 are significantly greater than one. For  $\Delta m$ , its coefficient in each of the three regressions is numerically *less than* one and is significantly less than one in the last regression. This rejects a prediction of the overshooting model. Similarly, the coefficient associated with  $\Delta \mu$ , the change in the expected growth rate of money, is numerically less than one in each case and significantly so in the last equation. The implication is a rejection of the overshooting model.

## CONCLUSIONS

Because many studies have found monetary shocks to have positive and persistent effects on the farm/nonfarm relative price ratio, the pursuit of a contractionary monetary policy to reduce inflation has been blamed for causing widespread financial distress in agriculture. Although an understanding of this literature is

certainly important to the debate about whether farm programs can or should be used to cushion the sector from changes in macroeconomic policies, the evidence on the response of farm prices and income to monetary policy actually has been widely mixed. In part, this diversity has been due to the different theoretical models and empirical techniques that have been employed.

Following a research strategy suggested by King (1979) to distinguish among alternative models and empirical results, a revised set of "stylized facts" emerges on the relationship between monetary actions and the relative price of farm products:

- Farm prices are significantly more variable than nonfarm prices.
- VAR results consistently show that monetary innovations explain less than 10 percent of the forecast error variance of the farm/nonfarm price ratio, whereas past innovations in the relative price ratio itself explain 80 percent or more of the error variance. Thus, while monetary effects may be statistically significant, they are economically unimportant.
- Although the flex-price/fix-price model is widely asserted to represent the economic structure generating the farm/nonfarm price series, its main hypotheses are rejected by the data. The standard interpretation of a Barro-type model also is rejected.



- Tests find the behavior of farm prices to be consistent with the neoclassical prediction of long-run neutrality; the "long run" for adjustments in the farm/nonfarm price ratio to a monetary change is less than one year.

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# The Multiplier Approach to the Money Supply Process: A Precautionary Note

**T**HE MULTIPLIER MODEL of the money supply, originally developed by Brunner (1961) and Brunner and Meltzer (1964), has become the standard paradigm in macroeconomics and money and banking textbooks to explain how the policy actions of the Federal Reserve influence the money stock. It also has been used in empirical analyses of money stock control and the impact of monetary policy actions on other economic variables.

One important feature of this model is that it decomposes movements in the money supply into the part that is due directly to Federal Reserve policy actions (the adjusted monetary base) and the part that is due to changes in technology and the tastes and preferences of depository institutions and the public (the money multiplier). In this decomposition, the multiplier is assumed to be independent of the policy actions of the central bank. The independence is implicitly predicated on the assumptions that the demands

for both checkable deposits and currency are determined by the same factors, and that individuals can quickly and costlessly alter their holdings of currency and checkable deposits to achieve the desired proportion of the two alternative forms of money.<sup>1</sup> Open market purchases, for example, increase reserves and consequently checkable deposits; but the public simply shifts from checkable deposits to currency until the (unchanged) desired ratio of currency relative to checkable deposits is once again achieved. Because policy actions have no impact on the public's holdings of currency relative to checkable deposits, the multiplier does not depend directly on the policy actions of the Fed.

This article investigates the theoretical and empirical validity of the key feature of the multiplier approach. In theory, the multiplier is independent of the policy actions of the Federal Reserve only if the demands for currency and checkable deposits are determined by identical

<sup>1</sup>The notion that the multiplier is independent of Federal Reserve actions—implicit in the work of Brunner and Meltzer (1964, 1968) and, more recently, in Plosser (1991)—has never been demonstrated rigorously with micro-economic principles. The argument presented here that would suggest such independence is implicit in works as early as Fisher (1911).

economic principles. The argument presented here that would suggest such independence is implicit in works as early as Fisher (1911).



factors and if, conditional on these factors, these demands are strictly proportional. From an empirical perspective, this condition is necessary but not sufficient; the degree to which the multiplier is influenced by policy actions also depends on the strength of the relationship between policy actions and checkable deposits.

An empirical analysis shows that most of the variability of the observed ratio of currency to checkable deposits is due to variation in checkable deposits, and thereby suggests that the demand for currency is not strictly proportional to the demand for checkable deposits. Prior to the Monetary Control Act of 1980 (MCA), however, the link between reserves and checkable deposits was quite loose—so much so, that the notion that the multiplier is independent of policy actions was operationally valid. Nevertheless, the empirical relevance of this notion has weakened considerably since the implementation of the MCA in the early 1980s. Since then, the relationship between Fed policy actions and checkable deposits and, thus, the multiplier has tightened markedly.

The evidence presented here, that the multiplier is not independent of Federal Reserve actions in the post-MCA period, raises some questions about the appropriateness of using the monetary base as an indicator of the effects of policy actions on the money stock. More important from a policy perspective, it also suggests a modification of the standard approach to money stock control that might yield substantial improvements in effective monetary aggregate targeting.

### THE MONEY MULTIPLIER APPROACH: A SIMPLE EXAMPLE

As a starting point for understanding the decomposition of the money supply into the monetary base and the multiplier, note that the narrow money stock,  $M1$ , is defined as

$$(1) M1_t = TCD_t + C_t,$$

where  $TCD$  denotes total checkable deposits and  $C$  denotes the currency held by the nonbank public. The monetary base ( $MB$ ), not adjusted for changes in reserve requirements, is simply the sum of currency and reserves (including

cash in the vaults of depository institutions) in the banking system,  $R$ :

$$(2) MB_t = C_t + R_t.$$

Currency, supplied by the Federal Reserve on demand, reflects the portfolio decisions of the public rather than monetary policy actions. Reserves, in contrast, can be affected directly by the Fed's sales or purchases of government securities in the open market.

For simplicity, assume that the Federal Reserve has a simple system of reserve requirements, with required reserves,  $RR$ , given by

$$(3) RR_t = rTCD_t, \quad 0 < r < 1,$$

where  $r$  denotes the ratio of reserves that must be held against  $TCD$ .<sup>2</sup> A change in the reserve requirement ratio,  $r$ , also would constitute a monetary policy action by the Fed.

Furthermore, for simplicity, assume that actual reserves always equal required reserves so that excess reserves are identically zero. With this simplifying assumption, equation 3 can be rewritten as

$$(4) R_t = rTCD_t.$$

The model is completed by assuming that currency is held in some proportion,  $k$ , of  $TCD$ . That is,

$$(5) C_t = kTCD_t,$$

where the proportion  $k$ , hereafter called the  $k$ -ratio, is the public's desired ratio of currency to  $TCD$  holdings.

Combining equations 1, 2, 4 and 5 produces the monetary base-multiplier representation of the money supply:

$$(6) M1_t = m MB_t,$$

where  $m$ , the money multiplier, is given by

$$(7) m = (1+k)/(r+k).$$

According to this representation, a policy action that increases  $R$  by one dollar, through open

<sup>2</sup>Since the Fed eliminated reserve requirements on all non-transaction deposits in December 1990, this representation approximates the current system. For convenience of ex-

position, the discussion to follow abstracts from reserves that depository institutions must hold on government and foreign transactions balances.



market purchases of government securities, increases MB by one dollar and the money stock by  $m$  dollars.<sup>3</sup>

In this representation, policy actions are reflected not only in MB, through changes in  $R$ , but in  $m$ , through changes in  $r$ . With a simple adjustment to MB, however, the effects of policy actions on the money supply can be isolated in one measure. This alternative measure of the monetary base, called the adjusted monetary base, AMB, reflects both changes in  $R$  and  $r$ . It is constructed by calculating the hypothetical level of reserves that would have been required under the reserve requirements in existence during a chosen base period for the current (actual) level of reservable deposits. With the chosen base period, changes in required reserves due to changes in reserve requirements,  $r$ , are added to the monetary base.<sup>4</sup>

Specifically, the AMB is given by

$$(8) \text{AMB}_t = \text{MB}_t + \text{RAM}_t,$$

where the reserve adjustment magnitude, RAM, is defined as

$$(9) \text{RAM}_t = (r^* - r)\text{TCD}_t.$$

This adjustment measures the reserves released or absorbed by changes in  $r$  relative to  $r^*$ , the required reserve ratio during the base period. In the base period, RAM is zero and  $\text{AMB} = \text{MB}$ . A decrease in  $r$  from its base-period level ( $r^*$ ) releases reserves into the banking system and thereby increases RAM and AMB. Conversely, an increase in  $r$  reflects the reserve drain by reducing RAM and AMB.

Combining equations 1, 4, 5, 8 and 9 yields the following decomposition of  $M1$ ,

$$(10) M1_t = m^* \text{AMB}_t,$$

where

$$(11) m^* = (1 + k)/(r^* + k).$$

In this characterization of the money supply process, all changes in monetary policy, through changes in  $r$  or  $R$ , are reflected in the AMB. Changes in the multiplier reflect only changes in the public's desire to hold currency relative to checkable deposits, changes in the  $k$ -ratio.<sup>5</sup> Because, in this model, the  $k$ -ratio is not directly influenced by the policy actions of the Fed, the multiplier is independent of policy.

### THE DEMAND FOR CURRENCY, CHECKABLE DEPOSITS AND NEAR-MONIES: WHAT IS THE $k$ -RATIO?

Interest in the currency-deposit ratio dates back to Fisher (1911), who was concerned that the two forms of money had different income velocities. He realized that these two monies are imperfect substitutes: currency is especially useful for making small, "face-to-face" transactions, while checkable deposits provide a convenient means for making large, "out-of-town" transactions.

Fisher reasoned, however, that individuals achieve an "equilibrium" in their holdings of the two forms of money. The notion of a desired or optimal  $k$ -ratio is based on the assumption that individuals decide how much of their money holdings they will allocate between currency and checkable deposits, based on both the relative advantages of each in undertaking an individual's planned transactions and their relative holding cost. This ratio was assumed to be a

<sup>3</sup>Note that because  $r < 1$ ,  $m > 1$ . If the assumption that excess reserves are not held were replaced by the assumption that they are held in a fixed proportion,  $e$ , of TCD, then the denominator of the multiplier would include  $e$  as well, so that the multiplier would be smaller than that shown in equation 7.

<sup>4</sup>See Tatom (1980), for example, who discusses the issue of choosing the appropriate base period in light of changes in the structure of reserve requirements. This theoretic discussion focuses on the measure of the adjusted monetary base constructed at the Federal Reserve Bank of St. Louis. See Garfinkel and Thornton (1991) for a more detailed discussion of this measure and a similar one constructed by the Federal Reserve Board.

<sup>5</sup>In a slightly more realistic model, which allows for the fact that depository institutions must hold reserves on govern-

ment and foreign transaction balances,  $m^* = (1 + k)/(r^*(1 + g + f) + k)$ , where  $g$  and  $f$  denote the ratios of government and foreign transactions accounts to TCD, respectively. If, in addition, excess reserves were held, as described in footnote 2,  $m^* = (1 + k)/(r^*(1 + g + f) + k + e)$ . These complications can be ignored, however, because movements in the observed ratio of currency to TCD explain most of the movements in the multiplier, as will be discussed shortly.



function of a number of economic and social variables.<sup>6</sup>

Given these variables, the demands for currency and checkable deposits were thought to be strictly proportional to each other. Moreover, because individuals are free to adjust their holdings of the two monies quickly and costlessly, it was assumed that the actual currency-deposit ratio would deviate from the desired ratio for only a short period of time.<sup>7</sup> According to this line of reasoning, all changes in the observed currency-to-deposit ratio, denoted here by the K-ratio, are to be interpreted as changes in the desired ratio caused by one of these factors. While not numerically constant, as it was assumed to be in the previous analysis, the k-ratio was viewed as not being directly affected by monetary policy actions.

The following discussion, supported by subsequent empirical analysis, suggests, however, that the observed ratio of currency to checkable deposits can be and has been affected directly by the policy actions of the Federal Reserve.<sup>8</sup> This effect can emerge without changing the relative advantages of currency and checkable deposits or their relative holding cost.

### ***Substitutability, Holding Costs and the Optimal k-Ratio***

There are a number of reasons why one might question the assumption that changes in the observed currency-to-deposit ratio necessar-

ily reflect changes in the optimal k-ratio—that is, changes in the relative holding cost and advantages of currency and checkable deposits. First and perhaps foremost among these is that the demand for either of these forms of money might depend on a number of special factors that are unrelated to the demand for the other. Thus, changes in the relative advantages of these two forms of money might not be empirically important in explaining changes in the ratio of currency to checkable deposits.

For example, many believe that currency has no rival for illegal transactions. The same is true for foreign demand for U.S. currency by countries that need “hard currencies” for their domestic transactions.<sup>9</sup> To the extent that currency is held for these reasons, independent of factors that determine the demand for checkable deposits, policy actions can induce changes in TCD without affecting currency demand. Consequently, policy can alter the ratio of currency to TCD and, hence, the multiplier.<sup>10</sup>

One might also argue that changes in the relative holding cost of the two monies are not especially relevant for explaining observed changes in the currency-to-deposit ratio. The relative holding cost of the alternative monies is given by the difference between the rates of return on the two forms of money.<sup>11</sup> The return on holding currency is zero.<sup>12</sup> Although non-interest-bearing checking accounts (demand deposits) have an explicit return of zero, they can yield a

<sup>6</sup>Fisher assumed that the optimal k-ratio depended on real income or wealth, the degree of development of the business sector, population density, relative holding costs and custom and habit. (Checkable deposits were thought to be “superior” to currency, although money in any form was a superior good.) Cagan (1958) extends the list of determinants of the k-ratio considerably. Both he and Hess (1971) attempt to quantify the effects of such factors.

<sup>7</sup>Cagan (1958) recognized that, at times, restrictions might prevent the adjustment of the currency ratio. He explicitly considered the case of financial crises where banks suspended convertibility. He noted, “At these times individuals could not exchange deposits for currency, and the desired currency ratio undoubtedly exceeded the actual ratio...” Without such restrictions, however, individuals are free to adjust their currency holdings to the desired level very quickly and at a low cost.

The assumption that there exists a desired currency-to-deposit ratio and that individuals adjust their actual holdings of currency to their desired level was made operational for models of the money supply process by Karl Brunner and Allan Meltzer in a series of articles. See Brunner (1961) and Brunner and Meltzer (1964, 1968).

<sup>8</sup>It has long been recognized that policy actions can have an indirect effect on the multiplier through the presumed

effect of policy actions on economic variables such as real income or interest rates. It is argued that such variables influence the k-ratio or the other ratios that make it up—particularly, the ratio of excess reserves to total checkable deposits. See Mishkin (1989) for a more detailed discussion of this indirect effect.

<sup>9</sup>Because it is difficult to account for a relatively large amount of the total stock of U.S. currency outstanding, one should not be too surprised to find that, in the aggregate, demand for currency and checkable deposits are not closely related. See, for example, Avery, Elliehausen, Kennickell and Spindt (1986, 1987).

<sup>10</sup>This potential influence is illustrated below with an example. To be sure, longer-run movements in the K-ratio might be attributable to some factors that affect the relative advantages for the two forms of money.

<sup>11</sup>The discussion to follow focuses on the nonbank public's perspective. The relative holding costs to depository institutions generally will differ.

<sup>12</sup>Adjusted for inflation, it is minus the expected rate of inflation. Note that currency used for illegal transactions yields a greater return because of the tax avoidance. For foreigners, currency can yield a return that differs from zero due to the appreciation or depreciation of their home currency relative to the U.S. dollar.



positive implicit return—for example, free toasters for new customers, subsidized accounting and payment services, etc. The return on holding interest-bearing checking accounts is the net interest paid on these accounts plus free payment services.<sup>13</sup>

The relative holding cost of currency and demand deposits, however, is unresponsive to movements in market interest rates because the explicit returns to both assets are identically zero. Surprisingly, the same seems to be true for currency and interest-bearing checking accounts, even since the elimination of Regulation Q ceiling rates in 1986. Interest rates paid on interest-bearing checkable deposits included in TCD have been unresponsive to movements in short-term interest rates.<sup>14</sup> Despite the fact that the explicit holding cost of currency relative to that of checkable deposits has changed little, the observed ratio of currency to checkable deposits exhibited sharp swings during the 1980s. Thus, it is unlikely that changes in the public's holding of currency and checkable deposits are due primarily to changes in their relative holding cost.

### ***The Holding of Currency, Checkable Deposits and Other Financial Assets***

Thus, it would not appear that individuals simply shift their money holdings between currency and checkable deposits in response to variations in their relative advantages or holding cost. This conjecture would be reinforced by the fact that currency and especially checkable deposits are substitutes for other "near-money" stores of wealth, for example, money market mutual funds. From this broader perspective, the demands for currency and checkable deposits

are seen as being determined simultaneously with the demand for near-money assets.<sup>15</sup>

An important part of the determination of the ratio of currency to checkable deposits, therefore, is the degree of substitutability between currency and demand deposits on the one hand and between each of these money assets and near-money assets on the other. Although the explicit rates paid on TCD are relatively unresponsive to changes in market interest rates, rates paid on near-money assets can vary markedly with variations in other market interest rates. The effect of these variations on the proportion of M1 held in the form of currency, of course, depends on the degree of substitutability between near-money assets and the two forms of money. If currency is a relatively poor substitute for such assets while TCD is a relatively good one, the ratio of currency to TCD will change with changes in rates paid on such near-money assets because of changes in TCD.

The relevance of this substitutability between TCD and other near-money assets appears to have been heightened by the nationwide introduction of interest-bearing checking deposits in January 1981. Since then, the cross-price or interest elasticity of the demand for checkable deposits has increased. This increase is hardly surprising because the payment of interest on checkable deposits has made them closer substitutes for interest-bearing time and savings deposits. Indeed, some evidence suggests that individuals have shifted a significant portion of their "savings" balances into interest-bearing checking accounts.<sup>16</sup> Because these saving balances are substitutes for savings and money market accounts that have higher explicit returns, the interest elasticity of the demand for checkable deposits should have risen, while the interest elasticity of currency demand should not have changed.<sup>17</sup>

<sup>13</sup>Net interest is interest net of service charges. For a discussion of these, see Carraro and Thornton (1986). This explicit return also could be adjusted for inflation.

<sup>14</sup>Indeed, interest rates on the interest-bearing portion of TCD, called other checkable deposits (OCD), have changed little during the 1980s. The rate on OCD fluctuated between 5 percent and just over 5.5 percent during our sample period.

<sup>15</sup>This consideration raises a fundamental question—namely, what constitutes an appropriate monetary aggregate? In theory, monetary aggregation requires the "monetary" aggregate to be "weakly separable." That is to say, it must behave as a fundamental commodity with respect to consumption and other financial assets. There can be substitution between assets that compose the aggregate, but not between those that compose the aggregate and

those that do not. Some evidence suggests that, while currency and demand deposits satisfy this condition for weak separability, these two assets plus interest-bearing transaction balances do not. See, Fisher (1989), for example. Belongia and Chalfant (1989), among others, however, find that the data are consistent with the notion that the assets included in M1 and a grouping broader than M1 (currency and total checkable deposits) satisfy the weak separability condition. Thus, the empirical results in this line of research are not conclusive.

<sup>16</sup>See Sill (1990).

<sup>17</sup>See Thornton and Stone (1991) for a derivation of this result. These results are borne out empirically by simple linear regressions of the monthly change in both currency and other checkable deposits on a scale measure and the three-month T-bill rate.



Thus, changes in interest rates, whether policy induced or not, can have an asymmetric effect on the demands for currency and checkable deposits, with a direct effect on the proportion in which the alternative monies are held.<sup>18</sup> Although this asymmetric effect is likely to have played a larger role since the introduction of interest-bearing checking accounts in generating fluctuations in the ratio of currency to TCD, policy has induced changes in this ratio more directly since the MCA (as discussed below).

## DEPOSIT SUBSTITUTION AND THE MONEY MULTIPLIER

Provided that the demands for currency and checkable deposits are determined by factors that are independent of one another, monetary policy actions can have a direct influence on the relative holdings of each and, thus, the multiplier.<sup>19</sup> The channel of influence is most easily illustrated in the extreme case where the demand for currency is completely independent of the demand for checkable deposits. That is, equation 5 is replaced with

$$(5') C_t = C,$$

where  $C$  is a constant. Equation 1 also can be rewritten as

$$(1') M1_t = (1 + K_t)TCD_t,$$

where, as defined previously,  $K_t = (C/TCD)_t$  is the observed ratio of currency to TCD.<sup>20</sup>

Using equations 1' and 5' in place of 1 and 5, the money supply can be written as

$$(12) M1_t = m_t^* \text{AMB}_t,$$

where  $m_t^* = [(1 + K_t)/(r^* + K_t)]$ .

The crucial difference between this expression and equation 10 is that, here, policy actions af-

fect both the adjusted monetary base and the money multiplier. To see why, consider a policy action involving the purchase of T-bills in the market by the Fed. This policy action increases the stock of reserves and, assuming zero excess reserves, TCD. In the earlier formulation of his model, the  $K$ -ratio was assumed to be unchanged; the increase in TCD would be accompanied by a proportionate increase in currency, so that the observed ratio of currency to TCD,  $K$ , would not change. Thus, the effect of this policy action on the money stock would be isolated in the monetary base—the multiplier would be unaffected.

In the modified model, however, TCD increases while currency is constant. Consequently, the  $K$ -ratio falls and the multiplier,  $m^*$ , rises. In this instance, the change in monetary policy is reflected both in the adjusted monetary base, because of a change in  $R$ , and in the multiplier because of a policy-induced change in  $K$ . Although this argument is made in terms of a static model, the main point, that policy can influence the multiplier, would carry over into a more realistic dynamic model. Two of the more salient features of the longer-run consequences of this analysis are taken up in the shaded insert on page 54.

## THE RECENT BEHAVIOR OF THE K-RATIO

Figure 1 shows the  $K$ -ratio and the observed adjusted monetary base multiplier,  $M1/AMB$ , from January 1970 to November 1990. Note that the multiplier is essentially the mirror image of the  $K$ -ratio; the  $K$ -ratio accounts for much of the multiplier's short-run (month-to-month) variability and for the significant shifts in its longer-run "trends." Indeed, as shown in table 1, changes in the  $K$ -ratio alone explain over 80 percent of the month-to-month variability in

<sup>18</sup>The same would be expected for changes in the level of income. Indeed, Hess (1971) presents estimates indicating asymmetric effects of both changes in interest rates and income on the demands for currency and checkable deposits. It should be emphasized that this effect of changes in interest rates on the  $k$ -ratio is not the same as that which was alluded to earlier—i.e., through the relative holding cost of currency and checkable deposits (see footnote 8).

<sup>19</sup>Many researchers who have estimated currency demand equations have abstracted from the relationship of currency to TCD. For example, see Hess (1971) and Dotsey (1988).

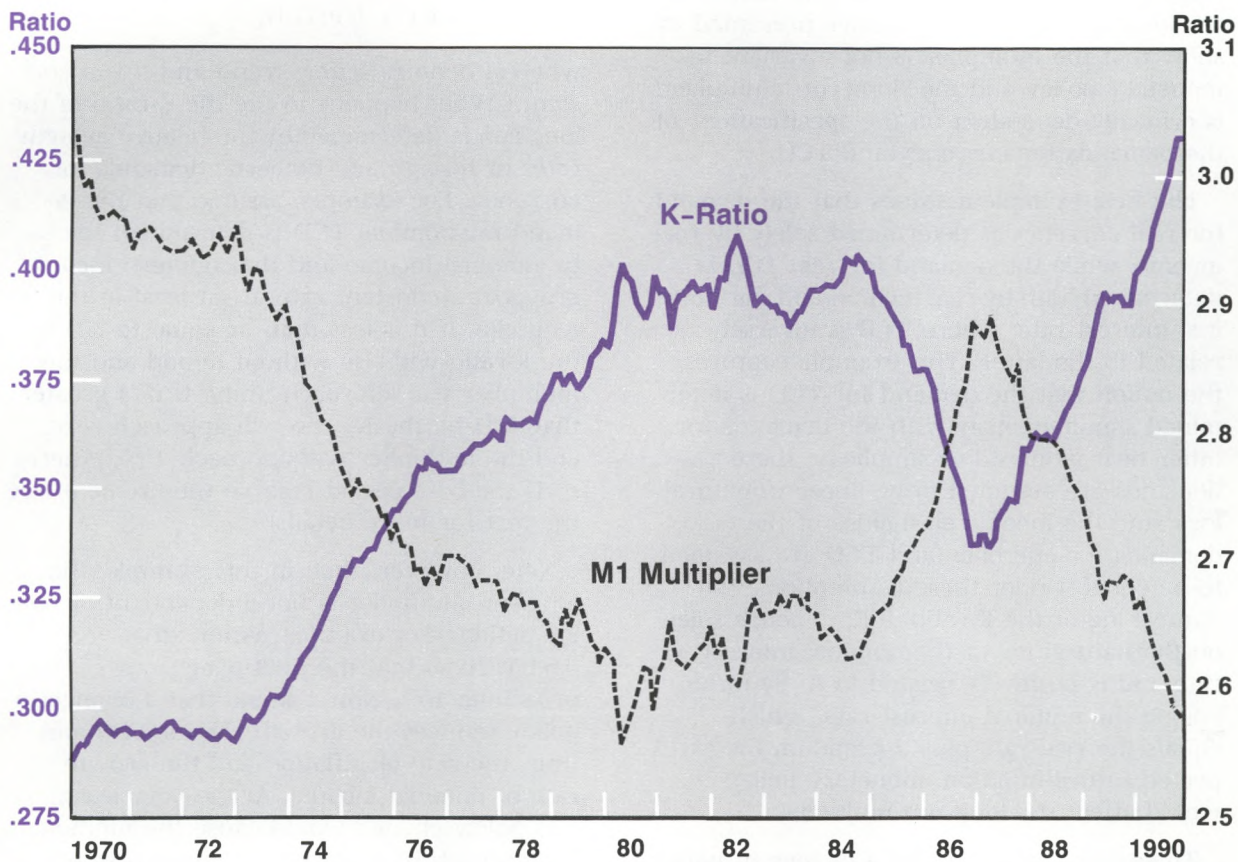
<sup>20</sup>Because  $k$  is meaningless in this formulation,  $K_t$  will not equal  $k$ . More generally, currency demand can be thought of as having two components, one related to TCD as embodied in the  $k$ -ratio and the other unrelated to TCD. That is,  $C_t = C + kTCD_t$ . In this more general formulation, the  $k$ -ratio is determined solely by the relative holding cost of currency and TCD and the substitutability between them as discussed above.

In this case,  $K_t = \frac{C}{TCD_t} + k$ . The restriction in (5'),

that  $k=0$ , is imposed only for illustrative purposes.



**Figure 1**  
**The K-Ratio and the M1 Multiplier**  
 January 1970–November 1990



**Table 1**

**Regression Estimates of Changes in the Multiplier on Changes in the K-ratio**

Period	Constant	K-ratio	SEE	$\bar{R}^2$	D.W.
1/1970-12/1980	.000 (0.35)	-4.355* (13.94)	.007	.598	2.47
1/1981-11/1990	.001 (1.84)	-3.714* (23.02)	.005	.818	2.49
3/1984-11/1990	.001 (1.35)	-3.504* (21.66)	.004	.854	3.02

\* indicates statistical significance at the 5 percent level.  
 Absolute values of t-statistics are in parentheses.



## The Long-Run Multiplier?

That the K-ratio does not appear to be stationary (in the sense of being mean-reverting) raises an interesting question of how the magnitude of the multiplier is determined in the long run. Two examples are presented to show that the multiplier is not invariant to monetary policy and the "long-run multiplier" is critically dependent on the specifications of the demands for currency and TCD.

The first example assumes that the demand for real currency is determined solely by real income, while the demand for real TCD is determined both by real income and the nominal interest rate, where TCD is inversely related to the latter. This example captures the notion that the demand for TCD is determined simultaneously with the demands for other near-monies. For simplicity, these demands are assumed to be linear in natural logs, and the income elasticities of the demands for currency and TCD are assumed to be equal. Under these assumptions, the natural log of the K-ratio,  $\ln K$ , depends solely on the natural log of the nominal interest rate and is positively related to it. By influencing the nominal interest rate, which equals the real rate plus a premium for expected future inflation, monetary policy would affect the long-run multiplier.

To see why, assume that a change in policy raises reserve growth permanently. If this increase results in a permanent increase in the actual and anticipated rates of inflation, the nominal interest rate will rise. The permanently higher level of the nominal interest rate will increase the level of the K-ratio causing a permanent reduction in the multiplier.

The second example assumes that the demand for currency is driven largely by forces external to the domestic economy, say, foreign demand for U.S. currency. It also assumes that the domestic demand for currency is determined solely by the relative holding cost of currency vs. TCD and that this cost is constant. Again, these relationships are assumed to be linear in the natural

logs. If the foreign demand grows at a constant rate,  $b$ , then the log of the demand for currency is given by

$$\ln C_t = b t + h \ln TCD_t,$$

where  $t$  denotes a time trend and  $h$  is a constant.<sup>1</sup> What happens to the the K-ratio in the long run is determined by the relative growth rates of foreign and domestic demands for currency. For example, assume that the demand for nominal TCD is determined solely by nominal income and that nominal income grows at a constant rate,  $d$ —at least in the long run. If  $d$  is less than or equal to  $b/(1-h)$ , the K-ratio will rise without bound and the multiplier will approach unity. If  $d$  is greater than  $b/(1-h)$ , the K-ratio will approach zero and the multiplier will approach  $1/r^*$ , where  $r^*$  is the base-period reserve requirement (see the text for more details).

Note, however, that, in this example, the long-run multiplier is not independent of policy actions. For example, assume that  $d > b/(1-h)$  so that the multiplier is approaching  $1/r^*$ . Now assume that a change in policy reduces the growth rate of TCD and, thus, the rate of inflation and the growth rate of nominal income. At the very least, this policy change would cause the multiplier to approach its long-run equilibrium value more slowly, as it drives down  $d$ . Indeed, if the growth rate of TCD slowed to the point where  $d < b/(1-h)$ , the long-run multiplier could converge to 1 rather than  $1/r^*$ .

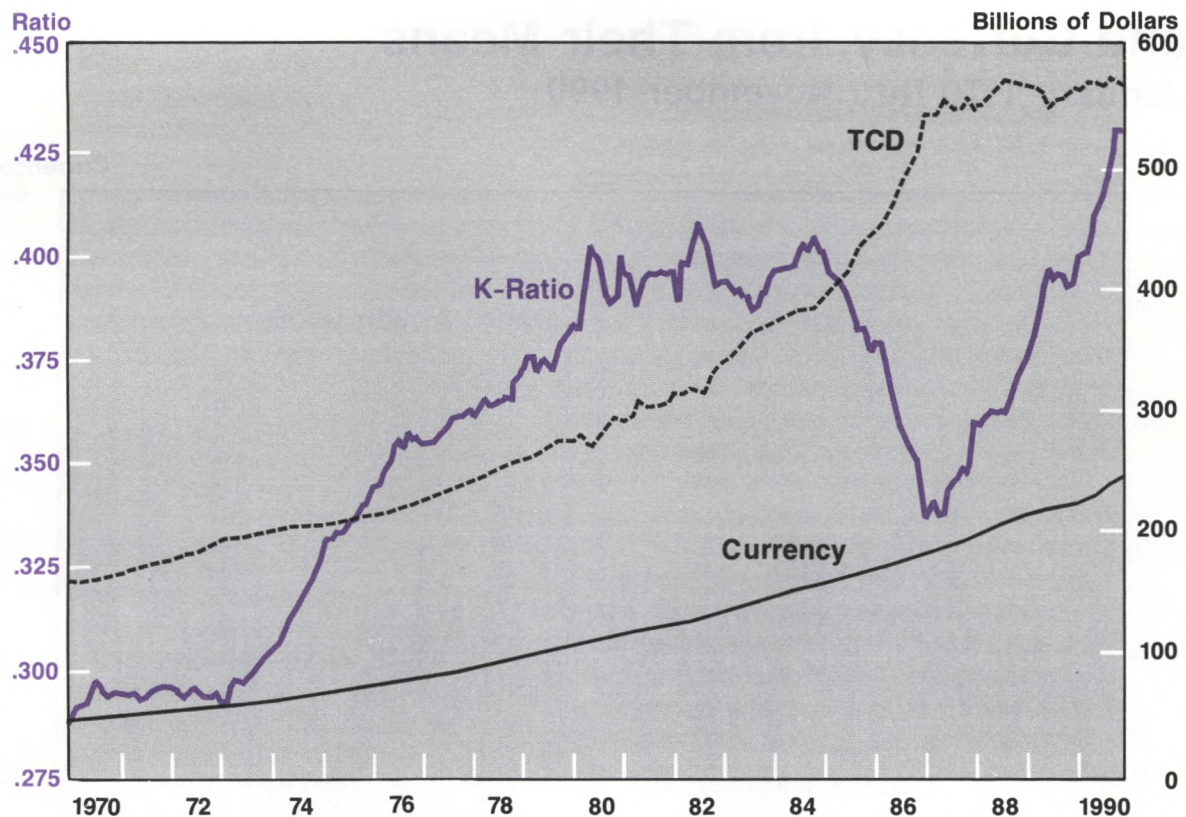
Of course, there are a number of other interesting possibilities. The major points that, even in the long run, the multiplier depends on monetary policy and that the exact value of the long-run multiplier between 1 and  $1/r^*$  depends critically on the specifications of the demands for currency and TCD are nonetheless valid. Before a meaningful "long-run" representation of the multiplier can be obtained, it is necessary to specify carefully both the demand for currency and the demand for TCD.<sup>2</sup>

<sup>1</sup>The parameter  $h$  might be thought of as the log of the optimal k-ratio, reflecting only the relative advantages and costs of currency and TCD.

<sup>2</sup>Note that, because the multiplier is bounded, M1 and AMB must be cointegrated.



**Figure 2**  
**The K-Ratio, Currency and TCD**



changes in the multiplier since the implementation of the MCA.<sup>21</sup> The MCA tightened the link between the K-ratio and the multiplier by reducing or eliminating other sources of variation in the multiplier.<sup>22</sup> While the MCA was implemented in a series of steps from November 1980 to September 1987, its major features were almost fully implemented by February 1984.<sup>23</sup> Since then, changes in the K-ratio alone explain over 85 percent of changes in the multiplier.

### *The Relationship Between Total Checkable Deposits and the K-Ratio*

Figure 2 shows the K-ratio, currency and TCD. The behavior of these series suggests that changes in the trend of the K-ratio are associated more closely with changes in the trend of TCD than with changes in the trend of currency growth. For example, the sharp rise in the

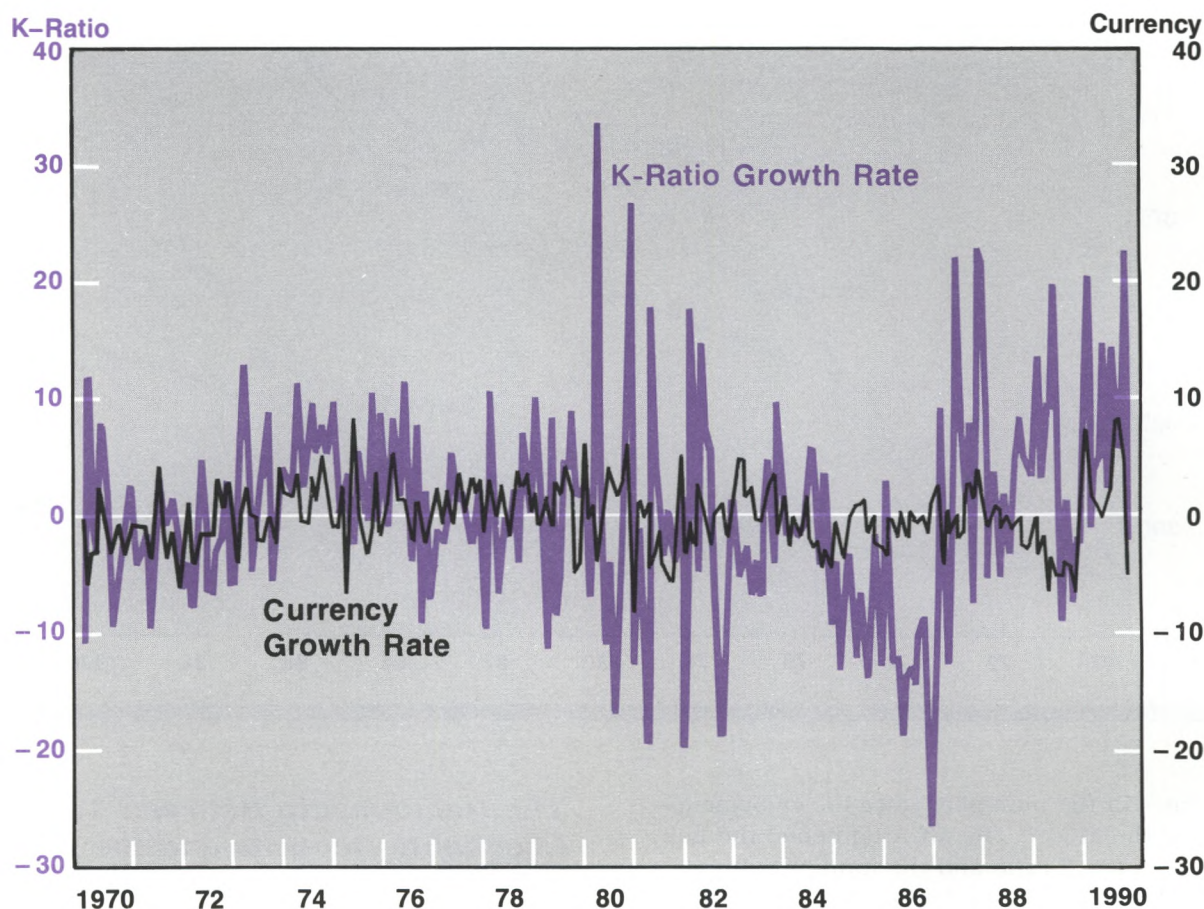
<sup>21</sup>The Durbin-Watson statistic for each of the equations indicates significant, negative first-order serial correlation. Because we are primarily interested in the explanatory power of changes in the K-ratio as measured by the adjusted R-square, however, maximum likelihood estimates of the equations adjusted for serial correlation are not reported here. Nonetheless, there are no substantive differences between the maximum likelihood estimates and those reported in table 1.

<sup>22</sup>See Garfinkel and Thornton (1989) for details.

<sup>23</sup>The MCA was first implemented in November 1980 and was fully phased-in by September 1987. The empirically significant features of the act were completed with the Fed's adoption of contemporaneous reserve requirements in February 1984, so the sample was broken at this point. See Garfinkel and Thornton (1989) for a discussion of these changes and their effect on the multiplier.



**Figure 3**  
**Deviations of the Growth Rates of the K-Ratio**  
**and Currency from Their Means**  
 January 1970 thru November 1990



K-ratio in the early 1970s is associated with a slowing in the growth of TCD. The decline in the K-ratio in the early 1980s and its subsequent rise are clearly associated with a sharp acceleration in the growth of TCD followed by a sharp deceleration in its growth.

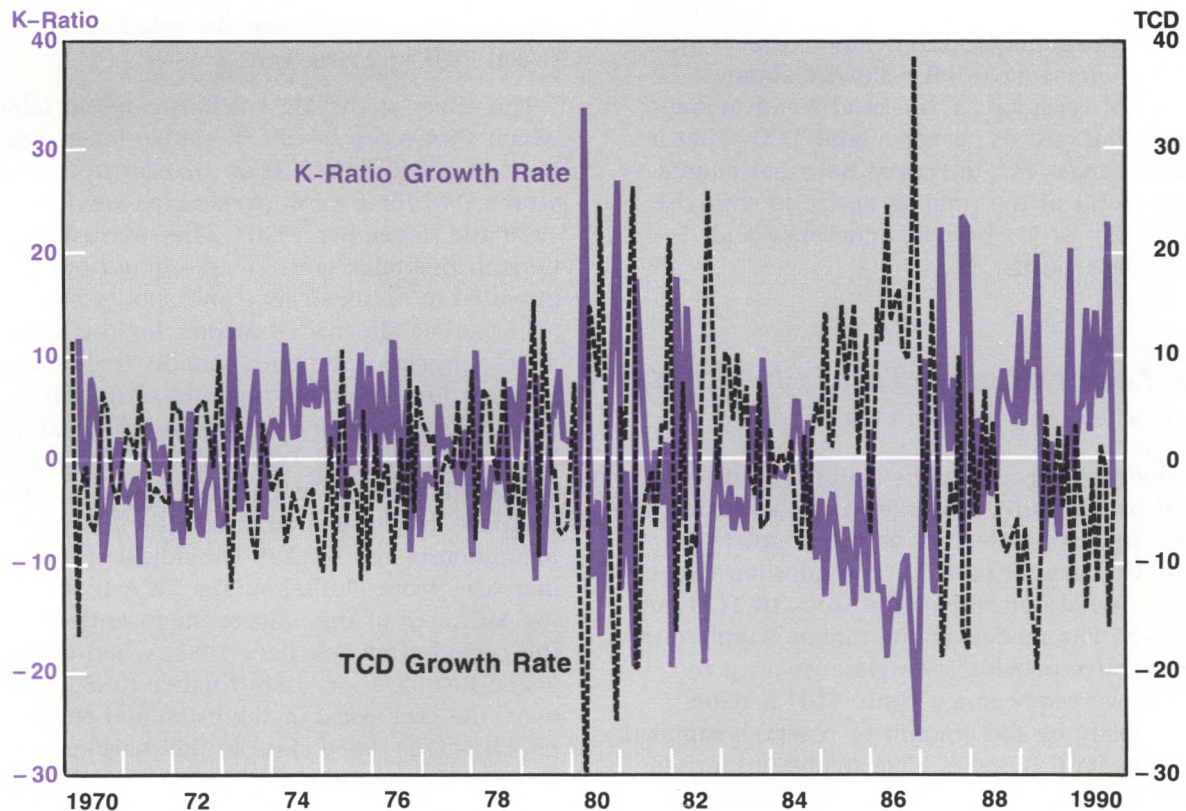
That TCD accounts for much of the short-run variation in the K-ratio also is evidenced by figures 3 and 4, which show, respectively, deviations of the growth rate of the K-ratio from its mean and deviations of the growth rates of currency and TCD from their respective means. As

shown in the figures, the month-to-month variability in the growth of TCD is considerably larger than that of currency. The variability of TCD more closely matches the variability of the K-ratio than does the variability of currency. While the growth rates of the K-ratio and TCD are highly, inversely related, there is little positive association between the growth rate of the K-ratio and the growth rate of currency.

This observation is verified in table 2, which shows the simple correlations between the monthly annualized growth rates for currency



**Figure 4**  
**Deviations of the Growth Rates of the K-Ratio**  
**and Total Checkable Deposits From Their Means**  
 January 1970 thru November 1990



and the K-ratio and for TCD and the K-ratio for four periods of roughly equal length between January 1970 and November 1990. If variation in the K-ratio were simply due to shifts between currency and TCD, its variation would be equally attributable to variation in currency and TCD.

This is not the case, however. The growth rates of currency and the K-ratio were positively correlated during only two of the four periods. They were negatively correlated in the other two, although the correlations are not significantly different from zero. In contrast, there is a strong, consistent negative correlation between the growth rate of TCD and the K-ratio during all four of the periods. Figures 3 and 4 and the correlations reported in table 2 clearly suggest that month-to-month variability in the

**Table 2**

**Correlations Between the Monthly Growth Rate of the K-Ratio and the Monthly Growth Rates of Currency and TCD**

Period	K-ratio and currency	K-ratio and TCD
1/1970-12/1974	.368*	-.901*
1/1975-12/1979	-.016	-.911*
1/1980-12/1984	-.112	-.955*
1/1985-11/1990	.265*	-.951*

\* indicates statistical significance at the 5 percent level.



K-ratio is driven largely by movements in TCD.

Finally, as shown in figure 4, periods of persistent deviations in the growth rate of TCD above (below) its mean are associated with persistent deviations of the growth rate of the K-ratio below (above) its mean. Consequently, both the short and long-run movements of the K-ratio are associated with movements in TCD rather than currency. The apparent importance of TCD in influencing the K-ratio suggests that K-ratio changes have not occurred simply because of variations in the relative advantages and holding cost of currency and TCD. That is to say, changes in the K-ratio have not been a simple result of the public's desire to shift the composition of M1 between currency and checkable deposits.

### ***The Link Between Total Checkable Deposits and Reserves***

Movements in the multiplier appear to be determined primarily by movements in the K-ratio, which, in turn, appear to be determined primarily by changes in TCD. The question that remains is what determines the stock of TCD outstanding? The models of the money supply presented above provide a simple answer: given the reserve requirement ratio, TCD is determined solely by the amount of reserves supplied by the Federal Reserve. This strong link arises in this model because reserves are assumed to be held only to support checkable deposits.<sup>24</sup>

Prior to the MCA, commercial member banks were required to hold reserves against all time

and saving deposits, while non-member banks and other depository institutions were not required to hold reserves against their transaction deposits in M1. Because of these factors, the link between TCD and reserves was not particularly strong. In reducing or eliminating reserve requirements on a number of non-transaction accounts and extending reserve requirements to all depository institutions, however, the MCA significantly strengthened the relationship between TCD and reserves.

The effect of the MCA is illustrated in table 3, which shows the results of simple linear regressions of *changes* in TCD on *changes* in total reserves, TR, for several periods between January 1970 and November 1990.<sup>25</sup> The regression equations in this table (and in subsequent ones) are intended to be illustrative and should not be interpreted as alternative models for the money supply process. (See the appendix for details.) In all cases but the initial phase-in of the MCA, there is a statistically significant relationship between changes in TCD and TR. The strength of the relationship, as measured by the adjusted R-square, however, increases after the implementation of the MCA.<sup>26</sup> The adjusted R-square increases from .06 before the MCA to .67 after the MCA. All of this improvement emerges in the period after February 1984, when the adjusted R-square increases further to .83.<sup>27</sup> Moreover, the reciprocal of the estimated coefficient on TR is .124, very close to the marginal reserve requirement of .12 during the latter period. Indeed, the null hypothesis that this coefficient is equal to 1/.12 cannot be rejected at the 5 percent significance level (the t-statistic is 0.62).

<sup>24</sup>In reality, of course, depository institutions hold excess reserves and are required to hold reserves on transaction deposits other than those included in M1.

<sup>25</sup>The total reserves measure used here is total reserves adjusted for reserve requirement changes, prepared by the Federal Reserve Board.

<sup>26</sup>The Durbin-Watson statistic for the first time period suggests that there is significant first-order positive serial correlation, as would be expected given the likelihood of misspecification (see the appendix). Maximum likelihood estimates of this equation adjusting for first-order serial correlation confirm this result. The estimated coefficient of first-order serial correlation is -.314 with a t-statistic in absolute value of 3.29. Nevertheless, the parameter estimates after adjusting for serial correlation are generally close to those reported in table 3, and they are statistically significant. More important, the adjusted R-square only increases to .147; hence, the dramatic rise in the adjusted R-square in the 1980s is not due to the fact that total reserve captures the autoregressive part of TCD.

<sup>27</sup>The switch from lagged to contemporaneous reserve accounting in February 1984 might explain some of this apparent improvement. To account for this possibility, the change in TCD was regressed on both the contemporaneous and lagged change in TR. In no case was the coefficient on lagged TR statistically significant from zero at the 5 percent level. Indeed, the results differed little from those reported in table 3. That the switch from lagged to contemporaneous reserve requirements is of no significant consequence is consistent with the conjecture of Thornton (1983) and the empirical evidence presented by Garfinkel and Thornton (1989). The relationship between TR and TCD will likely become even stronger given the recent elimination of reserve requirements on all time and savings deposits.



Table 3

**Regression of Changes in TCD on Changes in Total Reserves**

Period	Constant	Total reserves	SEE	$\bar{R}^2$	D.W.
1/1970-12/1980	.795* (5.72)	1.870* (3.10)	1.418	.062	1.35
1/1981-11/1990	.742* (3.42)	7.264* (15.64)	2.081	.674	2.23
1/1981-2/1984	1.765* (3.81)	2.704 (1.92)	2.414	.067	2.06
3/1984-11/1990	.441* (2.09)	8.082* (19.90)	1.676	.832	1.94

\* indicates statistical significance at the 5 percent level.  
Absolute values of t-statistics are in parentheses.

Table 4

**Regression Estimates of Changes in the Multiplier on Changes in Total Reserves**

Period	Constant	Total reserves	SEE	$\bar{R}^2$	D.W.
1/1970-12/1980	-.003* (2.86)	-.003 (0.67)	.011	.004	1.70
1/1981-11/1990	-.004* (3.28)	.016* (6.77)	.011	.275	2.12
1/1981-2/1984	.002 (0.77)	-.003 (0.42)	.014	-.023	1.82
3/1984-11/1990	-.006* (6.05)	.020* (11.07)	.007	.603	2.31

\* indicates statistical significance at the 5 percent level.  
Absolute values of t-statistics are in parentheses.

### *The Effects of Policy Actions on the Multiplier and the Money Stock*

The above analysis suggests that policy actions could exert a strong effect on the multiplier in the 1980s. Table 4 shows that this is the case. Changes in TR account for 60 percent of the variation in the multiplier since March of 1984. The table also shows that, because of the loose link between reserves and total checkable de-

posits, the assumption that policy actions had no effect on the multiplier was a reasonable working assumption before the adoption of the MCA. Indeed, changes in the multiplier are uncorrelated with changes in TR during the period ending December 1980.

These results suggest that there should be a dramatic change in the relationship between M1 and TR in the 1980s. Simple regressions of changes in M1 on changes in TR and changes in



Table 5

### Regression Estimates of the Change in M1 on the Change on Total Reserves and the Change in the Adjusted Monetary Base

Period	Constant	Total reserves	Adjusted monetary base	SEE	$\bar{R}^2$	D.W.
1/1970-12/1980	1.328* (8.86)	2.079* (3.20)		1.529	.066	1.28
	-.185 (0.74)		2.513* (7.73)	1.312	.312	1.54
1/1981-11/1990	1.868* (8.34)	7.251* (15.12)		2.149	.659	2.13
	-.280 (0.53)		2.773* (8.23)	2.939	.361	1.39
1/1981-2/1984	2.613* (5.33)	2.910 (1.95)		2.554	.070	2.00
	1.113 (1.51)		1.839* (3.20)	2.369	.200	1.86
3/1984-11/1990	1.696* (7.73)	7.995* (18.89)		1.746	.817	1.73
	-1.023 (1.43)		3.158* (7.48)	3.138	.407	1.33

\* indicates statistical significance at the 5 percent level.  
Absolute values of t-statistics are in parentheses.

the AMB, reported in table 5, bear this out.<sup>28</sup> TR explains a relatively small amount of the variation in changes in M1 before MCA and over 80 percent of the variation of changes in M1 since early 1984. The table also shows that the explanatory power of the monetary base has increased since the MCA, as would be expected.<sup>29</sup> Nonetheless, the explanatory power of the AMB declined significantly relative to that of TR.

### IMPLICATIONS FOR MONETARY POLICY

Prior to the MCA, when it appeared that the multiplier was independent of policy actions,

a rather simple, straightforward approach to money stock control was implied—namely, to target the level of the adjusted monetary base consistent with a money-stock target conditional on a forecast of the multiplier, where the multiplier forecast was not conditional on the target setting for the monetary base. This notion also implied that the adjusted monetary base is the best indicator of the effects of policy actions on the money stock.

The realization that the multiplier is *not* independent of policy actions suggests that the monetary base might not be the best indicator of policy actions on the money stock and that revising the simple empirical models of the

<sup>28</sup>Again, the Durbin-Watson statistics indicate significant serial correlation, especially when the AMB is used as the independent variable. In no case did an adjustment for serial correlation using a maximum likelihood technique alter any of the substantive results presented in table 5. That is, these results too suggest that there is a marked increase in the explanatory power of TR in the 1980s and

that changes in TR explain much more of the variation in changes in M1 in the 1980s than do changes in the AMB, even allowing for significant first-order serial correlation.

<sup>29</sup>See Garfinkel and Thornton (1989) for a discussion of this point.



money supply process to account for the effects of policy actions on the multiplier could result in improved money stock control. These issues are discussed briefly in this section.

### ***The Adjusted Monetary Base as an Indicator of Policy Actions on the Money Stock***

The adjusted monetary base continues to reflect all policy actions—changes in both reserves and reserve requirements; however, it does not fully capture the effects of these actions on the money stock. Indeed, changes in M1 are now more closely linked to changes in TR than to changes in the AMB. Consequently, it now appears that total reserves, adjusted for reserve requirement changes, is a better indicator of the effects of monetary policy actions on the money supply than is the adjusted monetary base.

Furthermore, the quantity of currency outstanding is demand-determined. Consequently, unlike adjusted reserves, the adjusted monetary base can give misleading signals of the course of monetary policy when there are exogenous shifts in the demand for currency.

To take a concrete example, currency growth accelerated markedly beginning about December 1989.<sup>30</sup> This acceleration was accompanied by a sharp acceleration in the growth of the adjusted monetary base from 3.4 percent in 1989 to 8.4 percent in 1990. Such a sharp rise in base growth would tend to indicate that monetary policy had eased. But the growth of adjusted reserves and, thus, TCD indicate a substantially weaker easing of policy. TCD increased at a 1.2 percent rate in 1990 compared with a -1.3 percent rate in 1989. Of course, the apparent exogenous increase in the demand for

currency caused the K-ratio to rise and the multiplier to fall, so that M1 grew slowly relative to the monetary base during the period.<sup>31</sup> Because there is now a closer link between TR and M1 than between the AMB and M1 and because TR is less likely to give misleading signals, TR is likely to be a better indicator of both monetary policy and the effects of policy changes on the money stock.

### ***The Multiplier Approach to Money Stock Control***

That the multiplier is not independent of policy actions also has important implications for the multiplier approach to money stock control. Taking this approach, the target level of M1 is achieved by forecasting the multiplier, then supplying the amount of the adjusted monetary base necessary to hit the desired M1 target.<sup>32</sup> If, however, the multiplier is a function of open market operations, policymakers must also predict the effect of their actions on the multiplier. That is to say, the multiplier approach to money control should be modified to take account of the effects of policy actions on the multiplier. Taking account of such effects undoubtedly will improve money control over the simple approach that assumes independence between the multiplier and policy actions. The magnitude of this improvement depends on how accurately the effects of policy actions on the multiplier can be forecast. To the extent that variations in the multiplier are largely explained by variations in the k-ratio and these variations are, in turn, largely influenced by policy (especially in the post-MCA period), such a modification could produce a substantial improvement in money stock control.<sup>33</sup>

<sup>30</sup>While the exact cause of this acceleration remains unclear, many attribute it (at least in part) to currency exports to South American and Eastern bloc countries.

<sup>31</sup>An equally interesting, but less frequently discussed, episode occurred during 1989 when, after remaining fairly constant, currency growth slowed abruptly. During this period, the K-ratio rose rather than fell, as one might expect given the apparent shift in the demand for currency. The increase in the K-ratio was driven by negative growth in reserves and, hence, TCD during this period.

<sup>32</sup>See Balbach (1981), Hafer, Hein and Kool (1983), and Johannes and Rasche (1979, 1987) for a discussion of this approach and for alternative methods that have been used to forecast the money multiplier.

<sup>33</sup>Note that the multiplier approach can be more difficult to implement. Most notably, the control problem becomes

nonlinear. One alternative approach would be to simply forecast the level of currency, then supply the reserves necessary to hit a target level of TCD. The target level of TCD would have to be consistent with both the M1 target and the forecast level of currency. Whether this or the multiplier approach, suitably modified to account for the effect of policy actions on the multiplier, would provide greater monetary control is an empirical issue well beyond the scope of this paper. Both approaches will produce forecast errors when there are unexpected shifts in the demand for currency. The real issue is whether better estimates of the K-ratio can be obtained by estimating the numerator and denominators separately than estimating them together. This is an empirical issue. Nevertheless, this alternative approach could be simpler to implement and might provide superior control if reasonably accurate forecasts of currency can be made.



## SUMMARY

This article has examined closely the standard multiplier model of the money supply process, specifically questioning the view that the adjusted monetary base multiplier is independent of the policy actions of the central bank. Because the demand for currency depends on a number of factors that are unrelated to the demand for checkable deposits (and vice versa) and because the stock of checkable deposits has been more closely tied to the quantity of reserves supplied by the Federal Reserve since the implementation of the MCA, changes in monetary policy result in changes in the ratio of currency to checkable deposits and, consequently, changes in the multiplier. Hence, the Federal Reserve's monetary policy actions are reflected both in the adjusted monetary base and the money multiplier.

Theoretical considerations suggest that the multiplier has never been independent of policy. The elimination of reserve requirements on some non-transaction accounts and the extension of Federal Reserve reserve requirements to all depository institutions has greatly increased the association between checkable deposits and reserves. These changes have increased significantly the association between changes in monetary policy actions and changes in the multiplier. That the multiplier is affected by policy actions suggests that money stock control using the multiplier model would be enhanced by taking the effect of policy actions on the multiplier into account. How much improvement can be expected with this modified approach and how effective alternative approaches to monetary control can be is left as a topic for further research.

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## Appendix

### A Model of the Money Supply Process

One might be tempted to interpret the regression equations in the text as representing alternative models of the money supply process; however, the reader is cautioned not to do so. Indeed, as the article suggests, some existing models of the money supply process are misspecified. This appendix illustrates the bias of some of the regression equations estimated in the article.

The discussion in the paper suggests that, since the MCA, there is a very simple linear relationship between TCD and TR of the form

$$\text{TCD}_t = a + b\text{TR}_t + e_t,$$

where the coefficients  $a$  and  $b$  are constants and  $e$  is a residual error that is assumed to be white noise. The error term arises because some reserves are held against transaction deposits not included in TCD and because depository institutions hold excess reserves. The constant term,  $a$ , enters the equation because a lower reserve requirement for a tranche of checkable deposits exists and because some of the variables omitted from this equation might have non-zero means. If TR is correctly adjusted for changes in reserve requirements, including the annual change in the deposit tranche, then the coefficients  $a$  and  $b$  should be constant; where  $b$  is the reciprocal of the marginal reserve requirement—that is,  $b = 1/.12 = 8.33$ . The discussion and the empirical evidence in the paper further suggest that currency holdings are independent of TCD, so that  $C_t$  is simply exogenous from the perspective of money stock control.

If this representation is true, then a regression of M1 on the monetary base is misspecified, because it imposes a restriction that is inconsistent with the process generating the data. To see this, consider the following regression specification:

$$(A.1) \text{M1}_t = g + s\text{MB}_t + q_t.$$

Given the definitions of M1 and MB, this equation can be rewritten as

$$(A.2) C_t + \text{TCD}_t = g + h\text{TR}_t + jC_t + q_t.$$

With the restriction  $h=j$ , equation A.2 is identical to equation A.1. The above analysis, however, suggests that the coefficient  $h$  should equal 8.33 and the coefficient  $j$  should equal 1. If this is the case, imposing the restriction that these coefficients are equal will be resoundingly rejected by the data.

To test this hypothesis, first-difference specifications of equations A.1 and A.2 are estimated using monthly data for the period from March 1984 through November 1990. These estimates use Federal Reserve Board data for the adjusted monetary base and total reserves, adjusted for changes in reserve requirements. These data come close to satisfying the identity that the monetary base is equal to the currency component of the money supply plus total reserves. These estimates are presented in table A.1. In the unrestricted version of the equation, neither the null hypothesis that  $h = 8.33$  nor the null hypothesis that  $j=1$  can be rejected at the 5 percent significance level. The  $t$ -statistic for the test that  $h=8.33$  is .59 and the  $t$ -statistic for the test that  $j=1$  is .25. Hence, it is not surprising that the restriction that  $h=j$  is soundly rejected by the data.

It is interesting to note that imposing this restriction biases the coefficient of the monetary base multiplier away from its true value. The estimated multiplier of 4.005 is nearly 50 percent larger than its average value during this period. This bias emerges because of an omitted variable.

To see this, note that equation A.2 could be rewritten as either

$$(A.3) \text{M1}_t = g + h\text{MB}_t + (j-h)C_t + q_t$$

or

$$(A.4) \text{M1}_t = g + j\text{MB}_t + (h-j)\text{TR}_t + q_t.$$

Hence, equation A.1 can be obtained by omitting  $C_t$  from equation A.3 or  $\text{TR}_t$  from equation



Table A.1

**Estimates of Equations A.1 and A.2**

Constant	$\Delta$ AMB	$\Delta$ TR	$\Delta$ C	SEE	$\bar{R}^2$	D.W.
-2.099* (2.49)	4.005* (7.48)			3.138	.407	1.10
.590 (1.21)		8.090* (19.67)	.908* (2.51)	1.690	.828	1.93

\*indicates statistical significance at the 5 percent level.  
Absolute values of t-statistics are in parentheses.

Table A.2

**Estimates of Regression of  $\Delta$ TCD on  $\Delta$ TR and  $\Delta$ C:  
March 1984 - November 1990**

Constant	$\Delta$ TR	$\Delta$ C	SEE	$\bar{R}^2$	D.W.
.581 (1.19)	8.069* (19.67)	-.115 (0.32)	1.685	.830	1.93

\*indicates statistical significance at the 5 percent level.  
Absolute values of t-statistics are in parentheses.

A.4. In the former case the estimate of  $h$  is biased downward (4.005 vs. 8.33); in the latter case the estimate of  $j$  is biased upward (4.005 vs. 1). Furthermore, the equation exhibits serial correlation, a common indicator of misspecification.

These results are not too surprising given that the demand for currency appears to be independent of the demand for TCD, as illustrated in table A.2, which shows the results of a regression of changes in TCD on changes in TR and changes in C. The coefficient on the change in C is negative, indicating a substitution between

TCD and currency, but is not significantly different from zero. Given this independence, it is hardly surprising that regressions of changes in M1 on TR and changes in TCD on TR produce nearly identical results. Comparing the results in table A.1 with those in table 5 shows that the coefficient is biased downward slightly when M1 is regressed on TR. This occurs because  $C_t$  is omitted from the right-hand side of the equation and because of the weak negative association between changes in both  $C_t$  and  $TCD_t$  and, hence, changes in  $TR_t$ .



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# Measuring State Exports: Is There a Better Way?

**T**HE RISING LEVEL OF U.S. EXPORTS in recent years has caused jobs and incomes in many states to become more closely tied to exports. To assess the economic effects of state exports, it is essential to have reliable information on the level of export activity by firms within the individual states. Such information is essential for numerous other purposes as well. For example, policymakers and others interested in state economic development require export data to assess the effectiveness of programs designed to stimulate export activity; they also require such data to assess the effects of trade policy changes, such as the proposed free trade agreement with Mexico.<sup>1</sup> Unfortunately, no ideal measure of state export activity currently exists.

This article describes the two available state export series and compares their estimates of manufactured exports. Such a comparison was

not possible until recently because the two series were not available for the same year. Our comparison for 1987 reveals that the two series provide conflicting information about export activity in many states.

The most prominent deficiency of both measures is that they are based on the value of export shipments by firms within a state rather than on the value of goods produced within a state that are exported. While this distinction may sound arcane, the discussion below indicates that it is not. Moreover, income and employment in a state are dependent on the latter measure, not on the value of export shipments. To address this deficiency, a third estimate of state manufactured exports is developed in this article. Comparisons show the differences between this new measure and one of the existing measures of export activity. Such a comparison further illuminates the shortcomings of the two

<sup>1</sup>As reported in *Business America* (1991), state governments engage in a wide variety of activities to promote exports. These activities include overseas trade missions, technical assistance (such as seminars on the legal and financial aspects of trade), and the dissemination of trade leads. Seven states have export finance programs; 41 states maintain offices in 24 countries to promote trade. These promotional activities raise the issue of whether international exports by firms within a state generate different economic results than domestic exports (or exports to other states by firms within a state). Empirical evidence to

assess whether such a distinction is meaningful in an economic sense is scarce. See Webster et al. (1990) for evidence that the employment effects of international exports exceed those of domestic exports for many industries.



available series and the advantages of a series like that developed here.

## EXISTING MEASURES OF STATE EXPORTS

Historically, the focus of U.S. trade data has been on country-to-country trade flows (that is, U.S. exports to and imports from individual countries). Recently, increasing attention has been focused on trade flows involving individual states. Exports of Boeing aircraft from Washington and imports of foreign cars by Missouri residents are just two examples of traded goods that have attracted attention to the fact that state jobs and incomes are related to the international economy. Our focus is restricted to export activity at the state level. To date, those interested in the magnitude of these flows have relied on two data sources published by the U.S. Census Bureau: *Exports From Manufacturing Establishments (EME)* and the *Origin of Movement of Commodities (OMC)*.

### *Exports From Manufacturing Establishments*

Approximately 56,000 of 220,000 manufacturing establishments are asked in the Annual Survey of Manufactures to report the total value of products shipped for export.<sup>2</sup> Since many establishments do not know the final destination of their products, the reported exports understate the value of all manufacturing export shipments. To compensate, the total amounts reported are adjusted to include estimates of exports by other distributors, such as wholesalers.

Differences between the directly reported values and the national total derived from Shipper's Export Declarations are allocated to states.<sup>3</sup> A Shipper's Export Declaration is a document that exporters must file which includes the value of each export shipment.<sup>4</sup> The allocation procedure is complicated slightly because the industry classification scheme used in Shipper's Export Declarations differs from that used in the Annual Survey of Manufactures. An additional complication is that the value of export shipments in Shipper's Export Declarations includes freight and wholesale margins. Since the value of export shipments in the *EME* is reported as shipments leave the plant, the costs associated with transportation and wholesaler activity must be removed from the values reported in Shipper's Export Declarations.

*EME* was first produced in 1960 as the *Origin of Exports of Manufactured Products*. It was produced at varying intervals until it became an annual report in 1983. This series possesses some significant shortcomings. First, the series is restricted to manufactured exports. It provides no information for establishments engaged in exporting services or unprocessed commodities produced by the agricultural, mining, forestry and fishing sectors.<sup>5</sup>

Second, this series is available with a two-year or more delay. For example, data for 1985 and 1986 became available in early 1989 and data for 1987 became available in 1991. Many analysts view these data as having only historical value because information on recent activity is not available for use in current decisions, such as those involving targeting export promotion expenditures.<sup>6</sup>

<sup>2</sup>At five-year intervals, a more comprehensive coverage of manufacturing establishments occurs with the Census of Manufactures. See appendix A of U.S. Census Bureau (1991) for details on the 1987 *Census of Manufactures* and the 1986 *Annual Survey of Manufactures*.

<sup>3</sup>For details, see appendix C of the U.S. Census Bureau (1991).

<sup>4</sup>A Shipper's Export Declaration must be filed for all export shipments except for those going to Canada. Effective November 30, 1990, this document was no longer required for Canadian shipments because of a decision to substitute Canadian import statistics for U.S. export statistics. See Ott (1988) for an explanation why Canadian import data are considered more accurate than U.S. export data.

<sup>5</sup>Processed food, forestry, petroleum and coal products that originate in these primary sectors are included as manufactured exports.

<sup>6</sup>Such decisions are also complicated by the fact that, until 1987, export data were generally unavailable at the three-

digit Standard Industrial Classification (SIC) level. The SIC is the standard by which establishment-based U.S. government economic statistics are classified by industry. For details, see U.S. Office of Management and Budget (1987). For manufacturing, 20 industries are identified at the two-digit SIC level. The industry becomes more narrowly defined as the number of digits for an SIC level increases. Prior to 1987, the export data were presented at the two-digit SIC level, or only for broad industries. An example of the disaggregation offered by the use of three-digit SIC codes is chemicals and allied products (SIC 28) which has eight industry groups: industrial inorganic chemicals (SIC 281); plastics materials and synthetics (SIC 282); drugs (SIC 283); soaps, cleaners and toilet goods (SIC 284); paints and allied products (SIC 285); industrial organic chemicals (SIC 286); agricultural chemicals (SIC 287) and miscellaneous chemical products (SIC 289).



The final and most important shortcoming is that this series reports the value of shipments instead of what is termed "value added." Value added is the value of a firm's sales minus the value of the goods and services it purchases from other firms to make its products. As the term implies, value added measures the dollar value a firm adds to the value of purchased inputs in its production process.

One way to calculate the market value of final goods and services produced during a year is to sum the value added at each stage of production by the firms in an economy.<sup>7</sup> To illustrate, assume an automobile producer had total sales of \$18 billion, of which \$10 billion reflect the value of steel, tires, plastics, electricity and other inputs used by the producer to make automobiles. The cost of these intermediate inputs is subtracted from the producer's revenue to calculate value added, so the automobile producer's value added was \$8 billion. This procedure is repeated for each firm in the economy; the sum of all firms' value added equals the total value of production within an economy.

Using the value of export shipments rather than the value added related to exports might be a misleading indicator of export activity in a state. Some manufactured products are not exported directly, but are combined as inputs with other resources to produce an export. If these inputs were produced in one state and transported to another for final processing, the value of export shipments from the latter manufacturing establishment in the exporting state would overstate the value added that actually occurred in that state.<sup>8</sup> The value of export shipments includes value added in both states.

A state's value of export shipments will exceed its export value added if its exporting firms rely heavily on inputs produced elsewhere or if its

firms produce relatively few inputs used by exporting firms in other states. On the other hand, the value of export shipments from a state will fall short of its export value added if its exporting firms produce more inputs that are used by exporting firms in other states than its firms purchase from elsewhere. Export value added and the value of export shipments will only be the same if the value of shipments used to produce exports in other states exactly offsets the value of inputs from other states that are used to produce exports. Overall, a state's value of export shipments may overstate, understate or equal the value added that actually occurred in the state. The empirical importance of this difference is examined below.

### *Origin of Movement of Commodities*

Prompted by a request from the transportation industry, a second export series, the *OMC*, began in 1987. The goal of this series is to identify where merchandise begins its export journey so that it can be tracked to its port. In the case of a manufactured good, the so-called "point of origin" does not require that the location of production of all component parts be identified, but rather where a completed manufactured good began its export journey. According to the instructions that accompany the Shipper's Export Declaration, the point of origin could be any of the following: 1) the state in which the merchandise actually began its journey to the port of export (indicated by the two-digit U.S. Postal Service abbreviation); 2) the state of origin of the commodity with the greatest share of value in a bundle of exports; or 3) the state of consolidation (the state where goods are consolidated by an intermediary for overseas shipment). In practice, the ports from which goods are shipped overseas are frequently used to identify the point of origin. This discretion in identi-

<sup>7</sup>The value added approach is one of three standard methods for calculating the market value of production. The other methods focus on income and expenditures. The income approach sums the incomes derived from economic activity, which are primarily wage, profit and interest incomes from employment of labor and capital resources. The value added in an establishment is the income generated by the establishment's activity. The expenditure approach sums four general categories of spending on goods and services: consumption, investment, government and net exports (that is, exports minus imports). The income and expenditure approaches are used more extensively in the United States than the value added approach. In the European Community, however, the value added approach is used extensively in the administration of taxes.

<sup>8</sup>Although such intermediate products are identified by the state of production as "supporting exports" in the *EME*, the state from which they are ultimately exported is not indicated. In addition, adding a state's supporting exports to its final shipments would result in some "double counting" of exports and overstate the value added associated with manufactured exports. Note that the national value of export shipments is a theoretically appropriate measure of value added because the sum of export shipments across all establishments does measure the market value of these manufactured exports. At the national level, there is no double counting. The shipments of intermediate inputs used for the exports are already included in the value of export shipments and are not added again in the calculation of manufactured exports.



fying the point of origin reflects the fact that determining the location of production is not a primary objective of this data series.<sup>9</sup>

Origin of movement totals are determined by sorting Shipper's Export Declarations by the state where a commodity became an export. A problem, however, is that Declarations for many shipments contain no point of origin. For example, in 1987 about 25 percent of the 9.7 million Declarations for shipments contained no state code. To make the data more useful, the Census Bureau contracted with the Massachusetts Institute for Social and Economic Research to develop estimates for the origin of shipments lacking state codes.<sup>10</sup> This expanded series is used in the following discussion and is referred to as the *OMC* series.

This newer series has some desirable characteristics relative to the export data provided directly by manufacturing establishments in the *EME*, although the older series is generally viewed as the more reliable of the two series.<sup>11</sup> One attractive feature of the *OMC* is that the data are available with a lag of months rather than years. In addition to manufactured exports, shipments data on nonmanufactured merchandise exports are provided. The initial foreign destination of these goods is provided as well. Consequently, information about state-to-country export flows is available for the first time. Like the *EME*, however, this series does not approximate the extent of value added in a state resulting from manufactured exports.

## A COMPARISON OF THE TWO SERIES

While there are several reasons why the two export series might differ, it is possible that the actual differences are small enough to allow the data to be used interchangeably. No comparison of the two series has been possible previously because 1987 was the first year for which the

data in the *OMC* were available and the 1987 *EME* was just released in April 1991. First, we compare each state's level of exports as indicated in the *EME* and the *OMC*. Next, we investigate whether a state's rank differs between the two measures. To complete the analysis, a particular facet of the linear relationship between the two export series is examined. See appendix A for details on the three methods used to compare the two 1987 series, as well as the two 1986 export series discussed later. If the two series are closely related, then the *OMC* data, which are available after a considerably shorter lag, could be used in place of the *EME* data.

## Comparing Levels: 1987 Export Series

Table 1 shows the value of 1987 manufactured exports according to the two series for the 51 "states" (50 states and the District of Columbia) and the total of the states. One reason the two series differ is that the data in the *OMC* include transportation costs and wholesale margins, while the data in the *EME* are the value of exports at the producing plant. This accounts for the bulk of the \$22.3 billion excess of the *OMC* state total over the *EME* state total in table 1.<sup>12</sup>

If these items were the only source of difference, the export value in the *OMC* for each state would be higher than the value in the *EME*. Also, the difference would be greater for those states farthest from major ports or a foreign border, reflecting the higher transportation costs. Table 1 shows that exports according to the *OMC* are higher than the level according to the *EME* in just 20 of the 51 states. This is in sharp contrast to the expectation that the *OMC* measure should be higher based on differences in its coverage and on the difference in the state totals. This discrepancy occurs primarily because of the *OMC*'s focus on where merchandise began its export journey. Since this location is often

<sup>9</sup>Smith (1989, 1990) notes that identifying the production locations of exported goods is especially difficult for agricultural and mined commodities. Small shipments of these commodities are often combined at storage facilities prior to reaching their port of embarkation. Shippers tend to report either the state of consolidation or the port as the state of origin.

<sup>10</sup>Details on the methods to generate these estimates can be found in Lerch (1990).

<sup>11</sup>See Farrell and Radspieler (1990) and Little (1990).

<sup>12</sup>Appendix B of the *Exports from Manufacturing Establishments: 1987* shows the difference between the value of exports at the port of export and the estimated plant value to be \$28 billion.



Table 1  
**Manufactured Exports by State for 1987**

State	1987 Exports <sup>1</sup>		Differences		Rank	
	EME	OMC	Levels <sup>2</sup>	Percentage <sup>3</sup>	EME	OMC
Alabama	\$2,138.6	\$1,896.8	\$ -241.8	-11.3%	25	26
Alaska	889.6	1,516.0	626.4	70.4	36	30
Arizona	2,086.0	2,772.7	686.7	32.9	27	21
Arkansas	1,353.0	636.1	-717.0	-53.0	33	41
California	22,996.1	30,448.7	7,452.6	32.4	1	1
Colorado	1,818.4	1,623.4	-195.0	-10.7	30	29
Connecticut	4,741.1	3,096.9	-1,644.2	-34.7	14	19
Delaware	519.7	842.0	322.3	62.0	43	35
District of Columbia	100.7	265.1	164.4	163.3	50	45
Florida	4,803.0	9,602.8	4,799.8	99.9	13	6
Georgia	3,561.1	3,380.1	-181.0	-5.1	20	18
Hawaii	175.3	153.5	-21.8	-12.4	47	49
Idaho	765.8	462.0	-303.8	-39.7	39	42
Illinois	8,687.8	8,471.5	-216.3	-2.5	7	8
Indiana	5,001.1	4,102.9	-898.2	-18.0	12	15
Iowa	2,552.6	1,756.3	-796.3	-31.2	24	28
Kansas	1,858.2	1,448.2	-410.1	-22.1	29	31
Kentucky	2,906.4	1,930.9	-975.5	-33.6	23	25
Louisiana	3,408.7	5,865.2	2,456.5	72.1	21	11
Maine	779.7	636.1	-143.6	-18.4	37	40
Maryland	1,927.9	1,881.1	-46.8	-2.4	28	27
Massachusetts	6,347.9	8,093.9	1,746.0	27.5	9	9
Michigan	12,412.0	17,618.2	5,206.2	41.9	4	3
Minnesota	4,733.3	3,850.1	-883.2	-18.7	15	16
Mississippi	1,712.1	1,122.3	-589.8	-34.4	31	32
Missouri	5,148.6	2,851.0	-2,297.6	-44.6	11	20
Montana	135.7	167.0	31.3	23.0	49	48
Nebraska	768.7	693.5	-75.2	-9.8	38	39
Nevada	170.3	356.8	186.5	109.5	48	44
New Hampshire	1,160.4	835.0	-325.4	-28.0	34	36
New Jersey	3,982.5	6,347.6	2,365.1	59.4	17	10
New Mexico	206.0	148.9	-57.1	-27.7	46	50
New York	11,824.0	17,614.8	5,790.8	49.0	5	4
North Carolina	5,670.6	4,898.0	-772.6	-13.6	10	13
North Dakota	222.6	217.4	-5.2	-2.3	45	47
Ohio	13,041.1	8,991.1	-4,050.0	-31.1	3	7
Oklahoma	1,355.4	991.3	-364.1	-26.9	32	33
Oregon	2,121.1	2,294.6	173.5	8.2	26	23
Pennsylvania	6,717.3	5,734.5	-982.8	-14.6	8	12
Rhode Island	691.9	408.5	-283.4	-41.0	40	43
South Carolina	3,234.7	2,159.6	-1,075.1	-33.2	22	24
South Dakota	270.3	56.0	-214.3	-79.3	44	51
Tennessee	3,567.2	2,309.3	-1,257.9	-35.3	19	22
Texas	14,046.3	22,662.3	8,616.0	61.3	2	2
Utah	589.1	757.0	167.9	28.5	42	37
Vermont	598.6	704.3	105.7	17.7	41	38
Virginia	3,656.6	4,750.8	1,094.2	29.9	18	14
Washington	10,841.7	11,793.9	952.2	8.8	6	5
West Virginia	1,126.2	920.0	-206.2	-18.3	35	34
Wisconsin	4,108.5	3,500.4	-608.1	-14.8	16	17
Wyoming	39.5	227.2	187.7	475.2	51	46
Total	\$193,571.0	\$215,863.5	\$22,292.5	11.5	—	—

Sources: EME: U.S. Department of Commerce, Bureau of the Census, *Exports from Manufacturing Establishments: 1987* (GPO, 1991). OMC: Massachusetts Institute for Social and Economic Research, University of Massachusetts, "U.S. Exports by State of Origin of Movement," data tape (1990).

<sup>1</sup>Millions of dollars.

<sup>2</sup>OMC value minus EME value.

<sup>3</sup>((OMC - EME)/EME)100.



identified as a port, the *OMC* estimates of exports are more concentrated in states that contain, or are near, major ports. Also, in some states where transportation costs might be expected to be relatively high, such as Nebraska and Kansas, the export value in the *OMC* is lower than the value in the *EME*, again contrary to the expectations based on transportation costs alone.

The importance of ports in the *OMC* data is further illustrated in figure 1, which plots the level of exports in each series. If each state's exports were identical in both series, all points would fall on the line labeled "line of equality." The points below the line of equality indicate that states' exports in the *OMC* often are lower than reported in the *EME*. In seven of the states labeled in figure 1—California (CA), Florida (FL), Louisiana (LA), Michigan (MI), New Jersey (NJ), New York (NY) and Texas (TX)—the value using the *OMC* is much higher than the value using the *EME*. In these states, total exports using the former measure exceed exports using the latter measure by almost \$37 billion. This pattern is consistent with the fact that data in the *EME* indicate the value of exports shipped from a state's manufacturers, while the data in the *OMC* are more likely to indicate the value of exports shipped from the state of consolidation or the port. Therefore, using the value in the *OMC* as a measure of a state's export activity can be misleading.

As table 1 shows, the percentage differences are also considerable for many states. For example, the value of exports from Wyoming measured in the *OMC* is nearly six times higher than that reported in the *EME*, while the *OMC* estimate for South Dakota is 79.3 percent lower. On average, the absolute value of the difference for a state is 44 percent; excluding Wyoming reduces the average difference to 35.3 percent.

The overall correspondence between the dollar levels of the two series is highlighted by calculating the simple correlation between them. This measure ranges from negative one to positive one and equals one when the two measures are perfectly correlated. In the present case, the correlation of .95 is high. Thus, when a state's *OMC* export value is higher than the average *OMC* export value using all states, the state's *EME* export value also tends to be higher than the average *EME* export value.

Figure 1 shows this general correspondence by plotting the states' 1987 exports as indicated

by the two series. Most observations cluster around the line of equality. Still, the substantial difference between the two series for several states indicates that the two measures are not identical.

### Comparing Ranks: 1987 Export Series

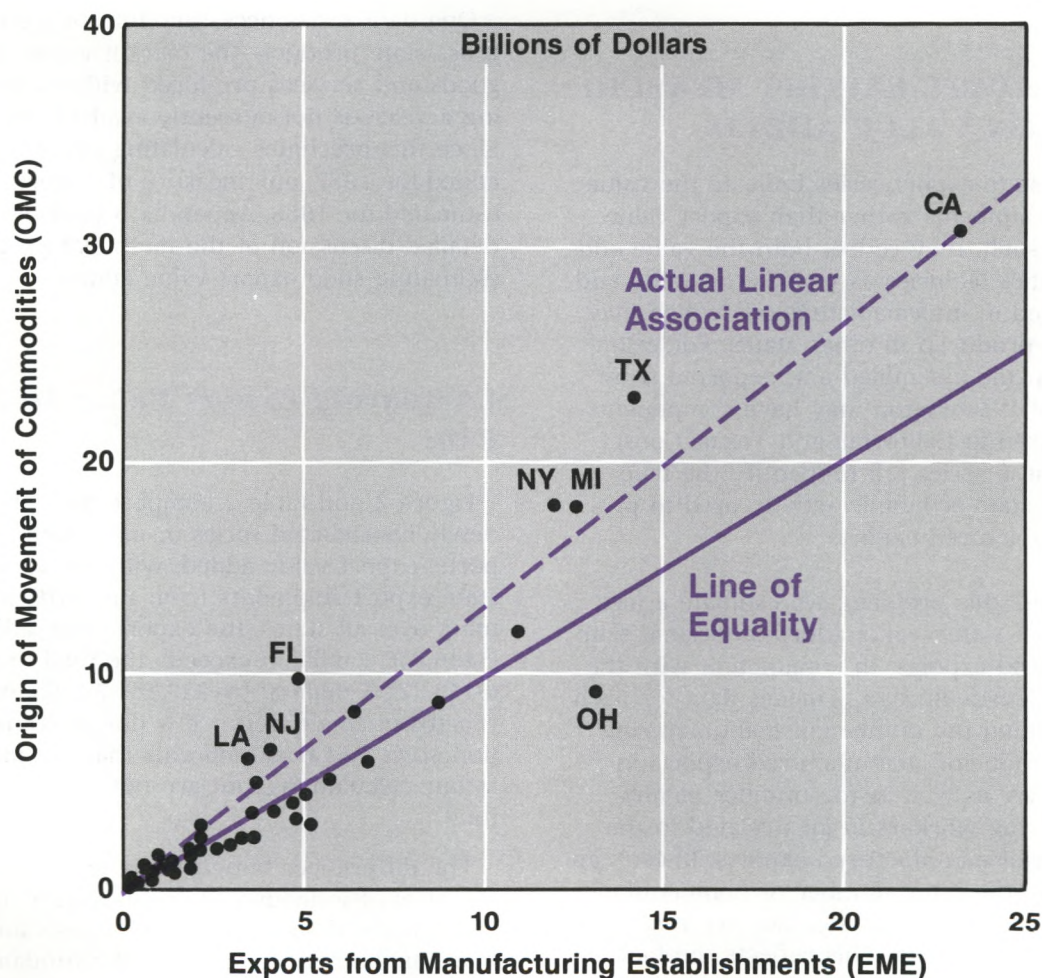
Another useful comparison between the two series involves ranking the states to see if states with larger (smaller) export values using one measure also have larger (smaller) export values using the other measure. Ranks are often used as a summary measure of a state's relative export performance. If each state had the same or, at least, a similar rank among the 51 states using either series, then the more current data in the *OMC* could be used to rank the states in a more recent year.

In view of the high simple correlation between the two series, it is no surprise that table 1 indicates a general similarity between a state's export ranks using the two measures. California and Texas, for instance, rank first and second in both series. This general impression is corroborated by the calculation of a Spearman rank correlation that allows for pairwise comparisons of the alternative proxies. This coefficient ranges from negative one to positive one; it equals one when measures yield identical rankings and minus one when the rankings are identically inversely related. The correlation between the two series' export ranks is .96, which is very close to one.

Although this high correlation indicates a close overall correspondence between the rankings according to the two series, policymakers or researchers who rely on the more current ranking available from the *OMC* as an indicator of the relative scope of export activity in a specific state can easily be misled. The ranking of each state in the *OMC* is not identical to the more reliable ranking in the *EME*. Florida and Louisiana, for example, rank considerably higher according to the *OMC*, due to the major ports in those states from which a large volume of merchandise is shipped. Missouri, on the other hand, ranks only 20th using the more current *OMC* measure, but is 11th according to the *EME*.



**Figure 1**  
**A Graphical Comparison of Two**  
**State Export Series: 1987**



### ***A Closer Look at the Linear Association Between the 1987 Export Series***

A more rigorous criterion to assess the interchangeability of the two measures reveals a substantial difference between the two series. This criterion, termed difference preservation, requires that the two export series differ by no more than some constant across states. If this

criterion is met, one export series could be reliably used as an index for the other.

If the OMC data preserved the difference in the EME data, the association between the two series could be illustrated by a line indicating equality of a state's exports, give or take some constant. In figure 1, such a line would be parallel to the line of equality. This is not the case, however. The dashed line, based on the actual linear association between the two series, is clearly not parallel to the line of equality. Con-



sequently, one measure is not interchangeable for the other. This means that researchers and other users of state export data in statistical studies should not use one measure as a proxy for the other because the results can vary depending upon which measure is used. In practice, this finding applies to the use of the more timely *OMC*-based measure as a proxy for the *EME*-based measure.

## A NEW STATE EXPORT MEASURE BASED ON VALUE ADDED

Existing state export series indicate the value of export shipments rather than export value added. As such, they reflect both the value added in a state's factories as well as the value added embodied in intermediate goods which may have been produced in other states. For example, an airplane assembled and exported from the state of Washington may have components manufactured in California and Texas. Consequently, these series fail to identify the true amount of state economic activity used to produce manufactured exports.

To address this problem, we estimate a measure of each state's value added associated with manufactured exports. In conjunction with the *EME*, the Census Bureau provides data for each state regarding the number of manufacturing workers producing manufactured exports in each industry as well as the number of non-manufacturing workers in jobs related to the production of manufactured exports. In fact, approximately the same number of nonmanufacturing jobs as manufacturing jobs are related to manufactured exports. This reflects the fact that manufacturing requires the productive efforts of workers (such as lawyers, accountants and transportation and communication workers) from various nonmanufacturing industries.

Unlike the value of export shipments, the level of export-related employment is directly related to the value added of exports in a state; such employees directly generate the value added. This employment information is used to esti-

mate state export value added. The estimates are based on the assumption that the productivity (output) of each export-related employee is no different than the average worker's productivity in that industry and state. Consequently, export value added in a state is equal to the sum over all industries of the number of export-related employees in a state multiplied by their productivity.

One data series necessary for such estimates, gross state product—the market value of the goods and services produced within a state during a year—is not currently available for 1987. Since this precludes calculating export value added for 1987, our measure of exports is estimated for 1986. Appendix B provides a detailed discussion of the methodology used in estimating state export value added.

## Comparing Export Value Added Vs. EME

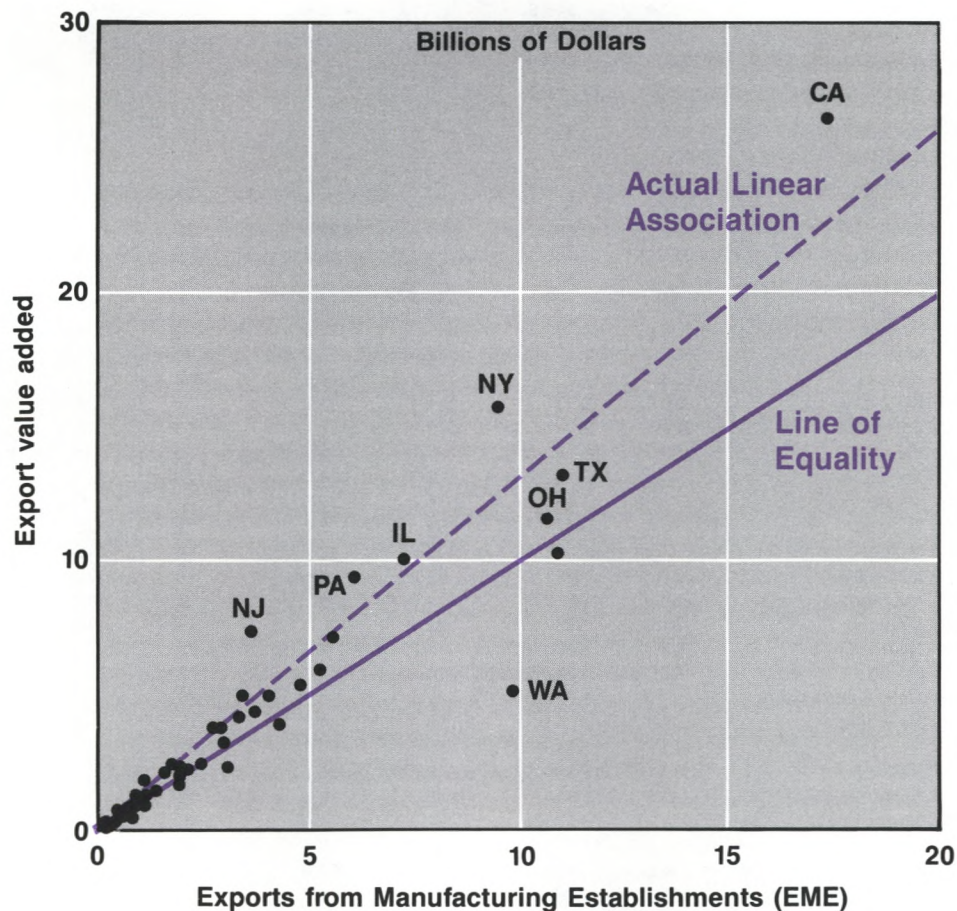
Figure 2 and table 2 compare the value of the newly constructed series of manufactured exports, export value added, with the value of state export shipments from the *EME*. Summing over all states, the export value added total (\$196,656.2 million) exceeds the total in the *EME* (\$159,374.5 million) by \$37,281.7 million. Three-fourths of this difference is due to transportation costs and trade margins that are included in our calculations, but are not in the *EME* total.

The differences between the two measures at the level of individual states, however, reflect much more than transportation costs and trade margins. Rather, they reflect the fundamental distinction between value added and value of shipments accounts. The state of Washington is especially noteworthy as the level of export value added is approximately one-half the level of exports in the *EME*. This suggests that manufacturing export shipments from Washington contain a large percentage of intermediate inputs produced elsewhere.<sup>13</sup> Using the export shipments value as a measure of this state's export activity is clearly misleading.

<sup>13</sup>This is consistent with the Washington State input-output model for 1982 (Bourque, 1987). For example, in Washington's largest export sector, aerospace, inputs from other states equal 56.2 percent of the sector's shipments.



**Figure 2**  
**A Graphical Comparison of Two**  
**State Export Series:1986**



Using export shipments values also can cause inaccurate inferences in terms of understating a state's export activity. For example, the export value added in 12 states exceeds the values in the *EME* by more than 50 percent. Wyoming, with an export value added that is more than nine times its *EME*-based export value, is by far the most extreme example. The primary reason is that firms in Wyoming process large quantities of oil and coal that are shipped to other states for use in manufactured exports.

While Wyoming is a small exporter regardless of the measure used, the large percentage differences are not restricted to relatively small ex-

porters. California, the nation's leading exporter by both measures, is estimated to export 53.5 percent more on the basis of value added than it does on the basis of shipment data. Thus, California firms are supplying large amounts of goods and services ultimately exported in the form of manufactured exports from other states.

These differences for many states between export value added and the *EME*-based measure of state exports raise the issue of the general association across all states between the measures. As was done above, the ranking of states' export value added was compared with the ranking of exports reported in the *EME* to



Table 2  
**Manufactured Exports by State for 1986**

State	1986 Exports <sup>1</sup>		Differences		Rank	
	EME	Value Added	Levels <sup>2</sup>	Percentage <sup>3</sup>	EME	Value Added
Alabama	\$1,684.9	\$2,427.1	\$742.2	44.1%	29	22
Alaska	712.9	545.8	-167.1	-23.4	38	43
Arizona	1,755.8	2,283.7	527.9	30.1	27	24
Arkansas	1,065.4	1,299.2	233.8	21.9	33	33
California	17,216.4	26,421.4	9,205.0	53.5	1	1
Colorado	1,477.7	2,087.0	609.3	41.2	30	28
Connecticut	3,996.4	4,968.0	971.6	24.3	13	13
Delaware	429.5	794.5	365.0	85.0	42	39
District of Columbia	91.0	194.3	103.3	113.5	50	49
Florida	3,372.6	4,966.2	1,594.0	47.3	16	14
Georgia	2,826.7	3,685.0	858.3	30.4	20	19
Hawaii	214.3	160.8	-53.5	-25.0	45	51
Idaho	502.6	548.1	45.4	9.0	40	42
Illinois	7,209.2	10,107.3	2,898.0	40.2	7	6
Indiana	4,787.4	5,352.8	565.4	11.8	11	11
Iowa	1,932.4	1,893.0	-39.4	-2.0	24	29
Kansas	1,835.0	1,690.3	-144.7	-7.9	26	31
Kentucky	1,939.8	2,191.2	251.4	13.0	23	26
Louisiana	3,020.3	2,374.9	-645.4	-21.4	18	23
Maine	800.6	799.6	-1.1	-0.1	36	38
Maryland	1,740.5	2,162.7	422.2	24.3	28	27
Massachusetts	5,513.8	7,139.8	1,626.0	29.5	9	9
Michigan	10,878.0	10,273.9	-604.1	-5.6	3	5
Minnesota	3,691.9	4,327.7	635.8	17.2	14	15
Mississippi	1,337.1	1,401.7	64.5	4.8	31	32
Missouri	4,267.9	3,896.3	-371.6	-8.7	12	17
Montana	101.2	232.8	131.6	130.1	49	48
Nebraska	753.3	808.0	54.7	7.3	37	37
Nevada	167.1	243.5	76.4	45.7	48	47
New Hampshire	892.6	1,193.0	300.4	33.7	35	34
New Jersey	3,548.1	7,248.5	3,700.0	104.3	15	8
New Mexico	177.7	335.4	157.7	88.7	47	44
New York	9,412.4	15,660.5	6,248.0	66.4	6	2
North Carolina	5,260.8	5,916.7	655.9	12.5	10	10
North Dakota	214.7	289.0	74.3	34.6	44	45
Ohio	10,653.0	11,561.7	908.7	8.5	4	4
Oklahoma	1,084.6	1,819.6	735.0	67.8	32	30
Oregon	1,862.7	2,264.5	401.8	21.6	25	25
Pennsylvania	6,026.6	9,373.2	3,347.0	55.5	8	7
Rhode Island	481.9	748.7	266.8	55.4	41	40
South Carolina	2,398.0	2,451.8	53.8	2.2	22	21
South Dakota	212.7	250.8	38.1	17.9	46	46
Tennessee	2,910.4	3,212.1	301.7	10.4	19	20
Texas	10,981.5	13,195.1	2,214.0	20.2	2	3
Utah	668.5	944.0	275.5	41.2	39	36
Vermont	384.0	651.3	267.3	69.6	43	41
Virginia	2,704.0	3,701.8	997.8	36.9	21	18
Washington	9,862.8	5,176.1	-4,687.0	-47.5	5	12
West Virginia	983.2	1,049.1	65.9	6.7	34	35
Wisconsin	3,313.5	4,163.6	850.1	25.7	17	16
Wyoming	19.1	173.2	154.1	806.9	51	50
Total	\$159,374.5	\$196,656.2	\$37,281.7	23.4	—	—

Sources: EME: U.S. Department of Commerce, Bureau of the Census, *Exports from Manufacturing Establishments: 1986* (GPO, 1989). Export Value Added: Authors' calculations.

<sup>1</sup>Millions of dollars.

<sup>2</sup>Export Value Added minus EME value.

<sup>3</sup> $((\text{Export Value Added} - \text{EME})/\text{EME})100$ .



determine whether states with larger (smaller) export values using one measure in 1986 also had larger (smaller) export values using the other measure in the same year. The two measures yield a general similarity between a state's export ranks. The Spearman rank correlation is .98, which is virtually one.

The ranks of a number of states, however, differ substantially across the two measures. Nine states have ranks that differ by five places or more. The largest changes involve Washington, which drops from fifth place using export shipments to twelfth place using export value added, and New Jersey and Alabama, both of which moved up seven places (New Jersey from 15 to 8 and Alabama from 29 to 22) when using value added.

The overall correspondence between these two measures is also indicated by the simple correlation between the two measures. The simple correlation is .95. This close correspondence is evident when the two series for each state are plotted as in figure 2. Many observations cluster around the line of equality reflecting the linear association between the two measures.

This strong association, however, does not mean that the two measures are interchangeable. In terms of figure 2, the actual linear association (identified by the dashed line) varies significantly in a statistical sense from the line of equality.<sup>14</sup> Consequently, one measure is not a reliable proxy for the other when used in statistical studies.

## CONCLUSION

Despite some improvement in available information on state export activity in recent years, the two existing state export series are deficient in several ways. Their most important limitation is that they both measure the value of shipments and not the extent of a state's economic activity (value added) related to manufactured exports. Nonetheless, as general indicators of export activity across all states, the two measures provide similar information. Despite this overall similarity, the two series can lead to substantially different conclusions when used for some states. Furthermore, the OMC series, which is available on a more timely basis, is not a satisfactory

proxy for the more accurate EME data on export shipments according to the criterion used in this article.

The estimate of a state's export value added generated in this article is inherently superior to the existing measures available for assessing state export performance. This new measure can produce different conclusions than shipments-based data when used for some states or when used in statistical studies. Consequently, users should reconsider their use of the existing export series when they desire an accurate measure of a state's value added related to manufactured exports.

The evidence presented here on export value added and its deviation from the EME-based export shipments measures is for one year only, however. The behavior of this discrepancy over time is unknown. This reinforces the importance of developing historical data on state export value added for analyses involving state export activity.

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<sup>14</sup>The dashed line indicates that a state's value added tends to be higher than its shipments. In particular, each dollar increase in state export shipments in 1986 was associated with a \$1.36 rise in export value added, on average.



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## Appendix A

### Interchangeability of Alternative Measures

The existence of alternative export measures raises the issue of the extent to which the measures are interchangeable. In other words, do these measures provide virtually identical information about state export performance? Different criteria exist for assessing this issue.

Three criteria are used here: 1) rank correlation criterion; 2) simple correlation criterion; and 3) orthogonal regression criterion. The rank correlation criterion focuses on the degree to which measures have identical rankings for corresponding observations. As a first step, states (including the District of Columbia) are ranked from 1 (the state with the largest value of exports) to 51 (the state with the smallest value of exports) for each export measure. To make pairwise comparisons of the rank-order, a Spearman rank correlation coefficient,  $R_s$  is calculated as follows:

$$(1) R_s = 1 - [6/N(N^2 - 1)] \sum_{i=1}^N (O_i - A_i)^2,$$

where  $i$  is a subscript denoting specific states ( $i = 1, 2, \dots, 51$ );  $O_i$  is the rank of the  $i$ th state using one measure;  $A_i$  is the rank of the  $i$ th state using the alternative measure; and  $N$  is the sample size.

If the rank-orders of the two measures are identical, then  $R_s = 1$ . For example, using one measure and assuming that three states—A, B

and C—had export values of 300, 200 and 100, the states would be ranked 1, 2 and 3. If, using the other measure, states A, B and C had export values of 5, 4 and 1, then an ordering of the states based on the two export measures would be identical and the Spearman rank correlation coefficient is one. A rank-order of zero means that the rank-orders of the two measures are not related. A rank-order of minus one means that the rank-orders are the reverse of each other. Thus, the closer  $R_s$  is to one, the more similar the rank-orders and the more interchangeable the measures for ranking purposes.

As indicated in the text, the Spearman rank correlation coefficient was approximately one for the comparison of the 1987 export measures in *EME* and *OMC* (.96) and the 1986 measures in *EME* and our export value added (.98). Consequently, the measures provide highly correlated rankings. These results suggest that, as a summary indicator of states' relative export performance, the measures provide roughly identical information. Satisfying this criterion, however, does not preclude large differences in a specific state's rank across the measures. For example, recall that the state of Washington dropped from fifth place using the shipments-based data in the *EME* for 1986 to 12th place using our export value added measure.

A stronger condition than rank correlation involves the simple correlation of the levels of the



alternative measures. The simple correlation coefficient provides information concerning the extent of a linear relationship between the alternative measures. The simple correlation coefficient is calculated as follows:

$$(2) r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{(\sum(x - \bar{x})^2 \sum(y - \bar{y})^2)},$$

where  $\bar{x}$  and  $\bar{y}$  are the sample means of the alternative export series,  $x$  and  $y$ .

For any given state, if the value of exports using one measure exceeds the mean of this measure based on all states by a certain amount and the value of exports using the other measure also exceeds (or falls below) its series mean by a set amount, then a perfect linear correlation exists. The value of the correlation coefficient will equal one (or minus one in the event of a negative relationship). For example, as in the numerical example above, assume states A, B and C had export values of 300, 200 and 100 using one measure. Using the other measure, assume states A, B and C had export values of 450, 250 and 50. Thus, A's exports exceed the first series mean of 200 by 100 using one measure, and exceeds the second series mean of 250 by 200 using the other measure. For a perfect linear correlation, C's exports (which are 100 less than the first series mean) must be 200 less than the second series mean (that is, equal 50). Since this is the case, the correlation equals one. A correlation coefficient of zero means that no linear relationship between the measures exists.

As indicated in the text, the linear relationship between both sets of measures is strong. For the 1987 measures in *EME* and *OMC*, the correlation coefficient is .95. For the 1986 measures in *EME* and of export value added, the correlation coefficient is also .95. Since these coefficients are virtually one, the measures can be viewed as interchangeable using this criterion.

When using a more stringent criterion, however, this is not the case. This criterion for interchangeability requires that the measures are not only highly correlated, but that they consistently differ by a constant, possibly zero. Once again,

assume states A, B and C had export values of 300, 200 and 100 using one measure. Using the other measure, assume state A had exports of 350. For "difference preservation," states B and C's exports must be 250 and 150. In this case, the two measures differ by 50 for each state. This difference preservation is known as an orthogonal regression criterion.<sup>1</sup>

Jackson and Dunlevy (1982) illustrate this criterion, in a time-series context, by a simple example of estimating a consumption function with different permanent income measures. Assume perfect correlation between two income measures  $y_1$  and  $y_2$ , so that:

$$(3) y_1 = a + by_2,$$

where  $a$  is the intercept and  $b$  is the slope. Suppose the following consumption function is estimated:

$$(4) c = d + ey_1 + \varepsilon,$$

where  $d$  is the intercept,  $e$  is the slope and  $\varepsilon$  is the random disturbance term. The slope is called the marginal propensity to consume and is the change in consumption associated with each \$1 change in income. If  $y_2$  is used rather than  $y_1$ , however, the consumption function becomes:

$$(5) c = (d+ea) + eby_2 + \varepsilon.$$

The two measures of income will yield the same estimate of the marginal propensity to consume only if  $b$  equals one.

Using orthogonal regression, we generated estimates of  $b$  for the alternative export measures discussed in the text. Specifically, we estimated two equations similar to equation 3. In one regression, the 1987 measures of state exports in *OMC* and *EME* were used as  $y_1$  and  $y_2$ , respectively. In the other regression, the 1986 measures of state exports based on our calculations of export value added and in *EME* were used as  $y_1$  and  $y_2$ , respectively.

The orthogonal regression criterion is not satisfied by alternative export measures. For the 1987 measures in *EME* and *OMC*, the or-

<sup>1</sup>In contrast to simple regression, the fitted line in orthogonal regression is the one that minimizes the mean square of the perpendicular (rather than the vertical) deviation of the sample points from the fitted line. See Malinvaud (1980), for a thorough discussion of the differences between orthogonal and simple regression.



thogonal least squares estimate of  $b$  equals 1.37. A  $t$ -statistic can be used to test the null hypothesis that  $b$  equals one.<sup>2</sup> The critical  $t$ -value for a 5 percent significance level with 49 degrees of freedom is 2.01, which is far below the actual  $t$ -value of 7.03. Consequently, the null hypothesis is rejected. Similarly, the 1986 measures in *EME* and of export value added produce an orthogonal least squares estimate of  $b$  (1.36), which yields a rejection of the null hypothesis that  $b$  equals one; the critical  $t$ -value of 2.01 at the

5 percent level of significance is far less than the actual  $t$ -value of 6.35.<sup>3</sup>

The implication of this analysis is that the levels of alternative export measures are not interchangeable using this criterion and their use would generate different regression results in otherwise identical estimations. Specifically, the coefficient estimates for the impact of a change in state exports on some variable of interest, say state economic growth, would differ depending on the measure used.<sup>4</sup>

<sup>2</sup>Because of random variation in the data it is unlikely that  $b$  exactly equals one. Therefore, the  $t$ -statistic is used to test whether we can reasonably infer that the estimated value of  $b$  equals one. See Jackson and Dunlevy (1981) for additional details on hypothesis tests involving the orthogonal least squares slope estimator.

<sup>3</sup>A related issue involves whether the two measures are consistently proportional to one another, that is, whether they tend to differ by a given percentage. This is investigated by testing whether the orthogonal least square slope estimator between the logarithms of the two measures significantly differs from one. Using the logarithms of the 1987 measures in *EME* and *OMC*, the slope estimate equals 1.01. The associated  $t$ -statistic is 0.109, which is less than the critical  $t$ -value of 2.01 (5 percent significance level). Consequently, the null hypothesis that the slope

equals unity cannot be rejected. These results suggest that the logarithmic forms of the two 1987 export measures in *EME* and *OMC* are interchangeable. On the other hand, the logarithmic forms of the 1986 measures in *EME* and of export value added yield an orthogonal least squares slope estimate of 0.892. Because the associated  $t$ -statistic of 2.95 exceeds the 2.01 critical value, the null hypothesis is rejected, suggesting that the two measures of 1987 exports are not interchangeable.

<sup>4</sup>See Coughlin and Cartwright (1987) for an empirical examination of the effect of manufacturing exports on employment for individual states. This is an example of a study where the regression results could be altered by using different export series.

## Appendix B

### Estimating Value Added Related to Manufactured Exports by State

In this appendix, we identify the data and methodology used to calculate the value added related to manufactured exports by state. We begin by identifying the variables used in the calculations and the data sources.

Various employment, shipments and gross state product data are essential for our calculations. Manufacturing employment (ME), export-related manufacturing employment (XME) and export-related nonmanufacturing employment (XNME) for each state are published in *Exports from Manufacturing Establishments: 1985 and 1986*,

U.S. Department of Commerce (1989).<sup>1</sup> ME is reported by respondents in the U.S. Census Bureau's Annual Survey of Manufactures, while XME and XNME are calculated by the Census Bureau.

Three other series are used. The first is unpublished data from the U.S. Department of Commerce (1991) on nonmanufacturing employment (NME). The second data series, which is published in *Exports from Manufacturing Establishments: 1985 and 1986*, is total state employment. The third data series, which is published by the U.S. Department of Commerce (1989), is gross state product (GSP). GSP is the

<sup>1</sup>For a detailed explanation of how these data were developed, see this publication's Introduction and Appendix C.



market value of the goods and services produced within a state during a year and is the state analog of U.S. gross domestic product. GSP data for individual manufacturing and non-manufacturing industries were used.

### **Methodology: Calculating Export Value Added**

To calculate total value added related to manufactured exports in state  $s$  ( $XTV_s$ ), we summed estimates of value added within the state's manufacturing sector ( $XMV_s$ ) and value added in nonmanufacturing sectors related to the export of manufactured goods ( $XNMV_s$ ). That is,

$$(1) XTV_s = XMV_s + XNMV_s.$$

Because identical data were not available for each manufacturing sector, the components of  $XMV_s$  were calculated in one of two ways.<sup>2</sup> For industries in which export-related data are published,  $XMV_s$  was estimated by applying the following equation:

$$(2) XMV_{si} = (GSP_{si}/ME_{si})(XME_{si}).$$

As defined above, GSP is gross state product, ME is manufacturing employment and XME is export-related manufacturing employment. The subscript  $i$  designates the different SIC manufacturing industry groups. In our calculations, we used the two-digit manufacturing industry group so  $i$  ranged from SIC 20 to SIC 39. This method implicitly assumes, for each industry, that output per worker in the production of export goods ( $XMV_{si}/XME_{si}$ ) is the same as output per worker in the production of all goods ( $GSP_{si}/ME_{si}$ ). Equation 2 was applied using data for individual industries rather than for total manufacturing, because this assumption is more plausible for each industry than for manufacturing as a whole.

For those manufacturing sectors with no published export-related employment at the two-

digit industry level,  $XMV_s$  was estimated using the following equation:

$$(3) XMV_{sm} = (GSP_{sm}/ME_{sm})(XME_{sm}),$$

where the  $m$  subscript refers to the total of those sectors not reported. For example, to compute a state's total unreported export-related manufacturing employment ( $XME_{sm}$ ), we simply subtracted the amount reported from the total export-related manufacturing employment. Consequently,  $XMV_s$  is the sum of the estimates for the reported industries ( $XMV_{si}$ ) plus the single estimate for the missing industries ( $XMV_{sm}$ ).

To compute a state's value added in its non-manufacturing sectors related to manufactured exports ( $XNMV_s$ ), we first estimated the following measure for each of a state's four nonmanufacturing industries [where  $j=1$ , trade;  $j=2$ , business services;  $j=3$ , transportation, communication and utilities; and  $j=4$ , other]:

$$(4) XNMV_{sj} = (GSP_{sj}/NME_{sj})(XNME_{sj}),$$

where GSP for the "other" sector is calculated as total state GSP minus manufacturing and minus the three nonmanufacturing industries, ( $j=1...3$ );  $NME_{sj}$  is nonmanufacturing employment in industry  $j$ ; and  $XNME_{sj}$  is export-related nonmanufacturing employment in sector  $j$ .<sup>3</sup> "Other" employment is total state employment minus employment in manufacturing, trade, business services and transportation, communication and utilities.

The state total for the value added in these nonmanufacturing sectors,  $XNMV_s$ , is simply the sum of the value added in the four nonmanufacturing sectors. The accuracy of this calculation, similar to the calculation for the manufacturing sectors, rests on the degree to which the productivity of export-related workers in sector  $j$  ( $XNMV_{sj}/XNME_{sj}$ ) is equal to the productivity of all workers in that sector ( $GSP_{sj}/NME_{sj}$ ).

<sup>2</sup>In some states, export-related manufacturing employment data were not published for certain industries either to avoid disclosing data for individual companies or because the estimate did not meet publication standards. Summing over all states, unpublished export-related manufacturing employment accounts for 1.8 percent of total 1986 export-related manufacturing employment.

<sup>3</sup>Export-related nonmanufacturing employment in the "other" sector accounts for 31.8 percent of the 1986 national total for such employment.





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