DM/85/45

INTERNATIONAL MONETARY FUND

Research Department

The Speed of Adjustment of the Inflation Rate: A Cross-Country Study of the Role of Inertia

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August 9, 1985

Contents

* The author is grateful to Charles Adams, Omotunde Johnson, Mohsin Khan, Malcolm Knight, Peter Montiel, Liliana Rojas-Suarez, Peter Wickham, and Philip Young for helpful suggestions and comments on an earlier draft. Any errors are the responsibility of the author.

I. Introduction

The speed of adjustment of the inflation rate in response to a sustained reduction in nominal aggregate demand has emerged as the central issue in the ongoing debate over the cost of disinflation. It is an issue on which a wide range of opinion exists. By definition, any reduction in the growth of nominal aggregate demand must be divided between a decline in the rate of inflation and a decline in the growth of output. When the inflation adjustment process is partial and slow, and is dominated by inertia in the short run, a slowdown in the growth of nominal spending has its main effect in reducing output growth rather than inflation. Thus, a restrictive monetary policy designed to reduce inflation will do so only at the cost of a substantial loss of output in the short run. On the other hand, if the inflation rate adjusts rapidly and completely, output will be insulated from the restrictive policies and the output cost of disinflation could be negligible.

Equilibrium theories, such as those of Lucas (1972, 1975), and Sargent and Wallace (1975), imply that the inflation rate responds contemporaneously and equiproportionately to an anticipated change in the money supply. This contention is based on the theoretical assumptions of rational expectations on the part of the public, perfect market clearing, and a one-period information lag. These views have led one equilibrium theorist to make the following optimistic, but well hedged, assertion:

> "... under the proper hypothetical conditions a government could eliminate inflation very rapidly and with virtually no Phillips-curve costs in terms of foregone real output or increased unemployment. The 'measure' that would accomplish this would be a once-and-for all, widely understood and widely agreed upon, change in the monetary or fiscal policy regime" [Sargent (1983, p.57)]."

In contrast, proponents of "inertia," or "core inflation" theories, including Okun (1981), Perry (1980), Gordon (1981, 1982a, 1983a), and Eckstein (1981), argue that since the inflation rate is incapable of adjusting quickly and effortlessly to changes in nominal aggregate demand, the output cost of ending inflation through an abrupt shift to a restrictive monetary and fiscal policy can be uncomfortably high. While equilibrium theorists take perfect market-clearing as their point of departure, these "orthodox" or "mainstream" theorists rely on non-market-clearing assumptions in the short run, with the result that the inflation rate responds sluggishly.

This paper empirically addresses the question of whether the inflation rate adjusts rapidly or sluggishly to changes in nominal aggregate demand. The answer to this question is obviously crucial for determining the scope and cost of anti-inflation demand policies. It is not the intention to

provide precise numerical measures of the speed of adjusment of the inflation rate. Instead, we explicitly compare the "unhedged" Rational Expections-Market Clearing (RE-MC) characterization of price behavior, 1/ which is that the inflation rate responds instantaneously and equiproportionately to an anticipated change in nominal aggregate demand, with the competing hypothesis that the inflation rate adjusts gradually to changes in nominal aggregate demand, whether anticipated or not. This competing hypothesis is fully compatible with the rational expectations hypothesis (without perfect market clearing), and also with the natural rate hypothesis and long run neutrality of output with respect to a permanent acceleration or deceleration in monetary growth. Nevertheless, in this alternative to the RE-MC view, prices adjust gradually in the short run and fully in the long run to anticipated changes in nominal aggregate demand. 2/ Gordon (1979, 1982a) calls this approach NRH-GAP, standing for the long-run Natural Rate Hypothesis combined with the short-run Gradual Adjustment of Prices. The NRH-GAP approach is based on the notion that the inflation rate depends at least partly on the past history of inflation rather than entirely on anticipated and unanticipated changes in the money stock or nominal aggregate demand.

The rest of the paper is laid out as follows. In Section II, some of the competing views on the speed of adjustment of the inflation rate and the cost of anti-inflation policies are summarized. The vast literature and wide spectrum of views on this topic make it necessary to be highly selective in the coverage for this section. The focus is on the RE-MC view in its unhedged and hedged versions, the credibility hypothesis, and the inertial inflation or NRH-GAP view. Monetarism and the "wage norm" views associated with Friedman and Okun, respectively, are not explicitly dealt with.

In Section III a single reduced-form equation for the inflation rate is developed and presented. The unhedged RE-MC hypothesis and the NRH-GAP hypothesis appear as special cases of this equation, which allows coefficient estimates to distinguish between the two. The model is due to Gordon (1982a) and it uses nominal GNP rather than the money supply as the aggregate demand

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1/ The corresponding "hedged" version of RE-MC refers to the quote from Sargent on page 1. In the hedged version, the characterization of price behavior described in the text occurs only "under the proper hypothetical conditions," namely a credible change in the policy regime. This point will be elaborated upon later in the paper.

2/ The importance of the distinction between anticipated and unanticipated monetary growth for the dynamics of the inflation process and speed of adjustment is stressed in Khan (1980). See also Khan and Knight (1982) where the implications of this distinction for the issue of inflationary finance are considered. These papers contain good references to studies of inflation in developing countries.

variable. Some estimation issues, including the decomposition of nominal GNP growth into its anticipated and unanticipated components, are discussed in Section IV.

The empirical results from tests of the model are presented in Section V. The tests were based on annual data from 13 developing countries--Brazil, Colombia, Greece, India, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Portugal, Thailand, and Turkey. 1/ These countries were chosen for the diversity of their inflationary experiences; the sample includes both low-to-moderate-inflation countries and high-inflation countries from Asia, Europe and the Western Hemisphere. Also, the countries chosen met certain minimum data requirements necessary for conducting the empirical tests. The empirical tests attempt to identify differences in the role of inertia in the inflationary process across the 13 countries. 2/ However, no attempt is made to explain such differences. The focus is on a general cross-country analysis, rather than detailed individual country studies.

The conclusions of the paper are summarized in Section VI. In brief, the main conclusion, which should be regarded as tentative and subject to several caveats, is that inflation adjusts sluggishly in at least half the countries studied. It is doubtful, therefore, that even an anticipated reduction in the growth rate of nominal aggregate demand will bring down the inflation rate quite rapidly, while having a negligible impact on output. However, it should be stressed that this conclusion does not undermine the basic point that to cut inflation it is essential to reduce the growth rate of nominal aggregate demand or the money supply.

II. Competing Views on Inflation Control and the Cost of Anti-Inflation Policies

As noted in the introduction, the coverage in this section will be highly selective. 3/ The objective is to highlight some of the salient features of the two main approaches that the empirical tests in subsequent

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1/ The period covered varied from country to country depending on the availability of data. In general, though, the coverage was from the mid-1950s to the early 1980s (see Tables 1 and 2 below for details). Full descriptions of the data used are presented in the Appendix.

2/ *See Gordon (1983c) for a similar study on eight large industrialized* countries.

3/ Gordon (1983b) contains a good description of a fairly wide spectrum of views, including wage-norm, "mainstream" or inertial, monetarist, credibility, and rational expectations. Taylor (1983) describes the "new classical macroeconomics" view, the "Keynesian" view, and also his own attempt at a consensus view. See also Group of Thirty (1981).

sections are designed to compare. They are, first, the inertial inflation or gradual adjustment of prices (NRH-GAP) approach, and second, the rational expectations-market clearing (RE-MC) approach and the related credibility hypothesis. The latter approach is firmly based on the flexible-prices, perfect-market-clearing paradigm with a Walrasian auctioneer and an efficient set of auction markets, while the former is based on a non-Walrasian, non-competitive, non-market-clearing paradigm, at least in the short-run. 1/

1. The NRH-GAP view

In this view, the inflation rate adjusts gradually in the short run and fully in the long run to changes in nominal aggregate demand, whether they are anticipated or not. The complete adjustment of the inflation rate in the long run makes this view fully compatible with the natural rate hypothesis (NRH) and the long run neutrality of output with respect to a permanent acceleration or deceleration in monetary growth. The short run gradual adjustment of prices (GAP) is due to inertia in the inflation process. That is, the inflation rate depends at least partly on the past history of inflation rather than entirely on anticipated and unanticipated changes in nominal aggregate demand. The main proponent of the NRH-GAP view is Robert Gordon. 2/

The inflation inertia aspect of the NRH-GAP view is also identified with Okun (1981), Tobin (1980), and Eckstein (1981). 3/ Inertial inflation may be defined as the tendency for an inflation rate, once established, to persist on its own inertia even when the original cause has been removed. In other words, whatever the historical origins of the inflation, once it is built into the system it continues very much on its own. Yeager (1981, p. 17) puts it as follows:

> "Something like Newton's first law of motion is at work...Just as a body resists being set in motion or having the speed or direction of its motion

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1/ The relative theoretical merits and demerits of these two paradigms are discussed in, for example, Buiter (1980), McCallum (1982), Grossman (1983), and they also get a good deal of attention in the conversations conducted by Klamer (1983) with the proponents for both paradigms.

2/ See, for example, Gordon (1979, 1981, 1982a, 1982b, 1982c, 1983a, 1983b, 1983c), and Gordon and King (1982).

3/ Besides "inflation inertia," some authors use terms such as "inflation momentum," "core inflation," and "underlying inflation." While there are some differences between these concepts, they are essentially similar since they all predict a gradual adjustment of the inflation rate.

> changed, so prices on the average resist changes in their level or their trend, particularly cuts in their level or moderation of their uptrend."

This stubborn, self-sustaining momentum of the inflation rate is often attributed to backward-looking or adaptive expectations. Since firms and workers set current and future nominal wages and prices partly as functions of their expected rates of inflation, an autoregressive or backward-looking model of inflationary expectations determines the actual rate of inflation as a long weighted average of past inflation rates. In Tobin's words:

> "The behavior that sustains [inertial inflation] may be interpreted as backward looking--emulating the behavior of other unions and other industries, catching up with reference groups, passing through historical costs, fulfilling explicit or implicit contractual agreements and mutual understandings. Or it may be interpreted as forward looking--estimating from past experience and other information the likely course of other prices and of market conditions during the periods of decision. It is doubtless both, and the two are tied together." [Tobin (1981, p.24)].

Besides expectations, another source of sluggishness in inflation, in the United States at least, is the existence of staggered wage contracts [see Fischer (1977, 1984), Taylor (1980, 1983), and Phelps and Taylor (1977)]. The contracting models of the inflation process posit rational expectations, and the source of inertia is the overlapping structure of multiperiod wage contracts. Firms and workers are locked into long-term wage contracts that were negotiated on the basis of wage and price expectations that prevailed in the past. Thus, due to contracts, the number and amount of changes in most wages and prices that can take place in a given time period is restricted. 1/

Indexation clauses that restore the real value of contracts after a fixed interval of time could also be a cause of inertia in the inflation rate [see, e.g., Arida and Lara-Resende (1985)]. This can be demonstrated quite simply as follows. Consider a case of monetary restraint during which the inflation rate is decelerating. Thus the inflation rate in period t-1 is greater than the inflation rate in period t. With comprehensive indexation in the economy, however, the inflation rate that exists in period t-1 is automatically transmitted into period t through index-linked contracts that are adjusted upward based on the previous

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1/ Although they both embody a measure of inertia in inflation dynamics, the expectations models and contracting models have different implications about the cost of disinflationary policies. See Sargent (1983) and Phelps(1984) for a discussion.

period's inflation rate. This transmission is independent of the actual rate of inflation in period t. Thus, when the inflation rate from period t-1 is transmitted into period t, the inflation rate in period t will exceed the rate that would have prevailed in the absence of indexation.

While a complete discussion of the micro-foundations of price and wage stickiness and of non-market clearing equilibria is beyond the scope of this paper, some other sources of inertia deserve mention. Rotemberg (1982), among others, stresses the role of the adjustment and transaction costs of frequent price revisions. Under this scenario, prices are sticky because firms face costs of changing their prices. These costs range from the costs of printing new price lists to the cost borne by firms as they upset their customers with frequent unanticipated price changes.

Blanchard (1983), among others, suggests that asynchronization of price decisions is also capable of generating price-level inertia. His argument is consistent with maximizing behavior and proceeds along the following lines: a nominal disturbance requires not just the change of a single price but of a complex structure of final good, intermediate good, and input prices. Since price decisions for each of these goods are not taken continuously, the price decisions across goods are not likely to be perfectly synchronized. Therefore, the process of adjustment of all prices to a new level implies movements of relative prices along the way. If price setters wish to avoid large changes in relative prices, the path of adjustment of all prices may be slow, that is, the price level may adjust gradually. In short, since price and wage decisions are made in a piecemeal way, an individual agent may not find it rational to promptly cut the particular price of wage for which he is responsible, even if it is above the general-equilibrium level. Instead of being first to change prices, the agent may rationally wait to see what others do. Thus, as in the prisoners' dilemma situation, there is a divergence between individual rationality and collective rationality [see Yeager (1981)].

Empirical studies conducted by Gordon (1982c, 1982d, 1983a, 1983c) show that there are considerable differences in the degree of inertia or stickiness observed over time and across countries. These differences are mainly due to institutional and cultural elements according to Gordon, and they do not have much to do with the credibility of the anti-inflation policies pursued in these countries. For example, he argues that the unique North American institution of three-year union wage contracts with staggered expiration dates is the prime cause of the inertia observed in the U.S., while nominal wage adjustment in Japan may be more flexible due to the alternative institutional arrangement of one-year contracts with virtually simultaneous expiration dates. Gordon (1983b) also attributes the success of nations such as Sweden and Austria in holding down unemployment to remarkably low levels, in the face of world-wide economic stagnation, to

the homogeneity and small size of these countries, which allows the establishment of a "social contract" that is impossible to achieve in larger and more disparate societies. In sum, in the NRH-GAP approach, the differences in the speed of adjustment of the inflation rate across countries and time is explained mainly by institutional and cultural features. However, more research needs to be done to completely explain these differences, a task that is not undertaken in this paper.

2. The RE-MC view

The Lucas-Sargent-Wallace-Barro (LSWB) "policy ineffectiveness proposition" asserts that real output responds only to unanticipated changes in nominal aggregate demand and not at all to anticipated changes. 1/ This proposition is based on the theoretical assumptions of rational expectations, perfect market clearing, and a one-period information lag. The LSWB proposition has the corollary that the inflation rate responds contemporaneously and equiproportionately to an anticipated change in nominal aggregate demand. This view implies that a dramatically quick disinflation can be achieved without a recession, and also that monetary policy is ineffective in stabilizing output and employment.

It is not correct to label the LSWB proposition and its corollary as the "rational expectations approach," since many economists accept the rational expectations hypothesis while rejecting the other assumptions, such as perfect market clearing, that are embodied in the LSWB proposition. Therefore, in this paper the LSWB approach is labeled as RE-MC, referring to the combination of rational expectations with the explicit assumption that prices and wages are perfectly flexible and that markets clear at every date. RE-MC models are also often called "equilibrium" models. 2/ However, the assumptions of rational expectations and perfect market clearing on their own are not enough to provide a plausible theory of business cycles, since continuous market clearing would maintain constant full employment. Therefore, equilibrium theories resort to the Lucas device of information limitations, and the temporary confusions they cause, in order to explain observed short-run Phillips curve trade-offs.

Sargent (1982, p. 90) notes that perhaps the most shrewd summary of the RE-MC view on disinflation that can be made in a single sentence is due to Paul Samuelson: "[RE-MC proponents] are optimistic that inflation can be wiped out with little pain if only the government makes credible

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1/ See Lucas (1972, 1975), Sargent and Wallace (1975), and Barro (1978).

2/ In fact, there is now a plethora of names to describe these models: "new classical macroeconomics," "monetarism mark II," "rational expectations with misperceptions," "the hard-line approach," and "the competitive market approach." See Taylor (1983) for references to the original users of these terms.

its determination to do so" (Newsweek, April 28, 1980). The rationale for this statement is that the RE-MC view denies that there is any inherent inertia in the inflation process. According to the RE-MC view, economic agents have come to expect high rates of inflation in the future and they set prices in light of these expectations. The reason that people expect high rates of inflation in the future is because the government's current and prospective monetary and fiscal policies warrant these expectations. RE-MC proponents go on to argue that current rates of inflation and people's expectations about future rates of inflation respond slowly to isolated actions of restrictive monetary and fiscal policy. These monetary and fiscal actions are viewed as temporary deviations from what is perceived as a long-term government policy involving high average rates of monetary expansion and government deficits in the future. In Sargent's (1982, p. 42) words:

> "Thus inflation only seems to have a momentum of its *own; it is actually the long-term government policy* of persistently running large deficits and creating money at high rates which imparts the momentum to the inflation rate."

This view implies that inflation can be stopped much more quickly than advocates of the NRH-GAP view have indicated, and that NRH-GAP estimates of the length of time and the output cost of stopping inflation are erroneous. However, Sargent (1982, p. 42) hedges his position by stressing that:

> "This is not to say that it would be easy to eradicate inflation. On the contrary, it would require far more than a few temporary restrictive fiscal and monetry actions. It would require a change in the policy regime: there must be an abrupt change in the continuing government policy, or strategy, for setting deficits now and in the future that is sufficiently binding as to be widely believed."

It is obvious from the above summary that the RE-MC view can be divided into an unhedged version and a hedged version. The unhedged RE-MC view is essentially the LSWB corollary: an anticipated change in nominal aggregate demand will result in an instantaneous and equiproportionate change in the inflation rate. The hedged RE-MC view says that this instantaneous and equiproportionate response of the inflation rate will occur only "under the proper hypothetical conditions." These conditions amount to a credible change in the policy regime.

While some authors [Gordon (1983b), McCallum (1984), and Mishkin (1984)] feel that the RE-MC view and the credibility hypothesis are two separate and distinct approaches, it is obvious from the hedged version

of the RE-MC view that credibility could play a crucial role in the disinflation process. Therefore, it would be useful to briefly look at the credibility hypothesis and its relationship with the RE-MC view.

The basic idea of the credibility hypothesis--first introduced into macroeconomics by Fellner (1976)--is that a "credible" (i.e., consistent, sustained, and believed) disinflation will be less costly, in terms of foregone output, than one that the public expects to be abandoned or aborted. 1/ In Fellner's terminology, the credibility hypothesis also implies that the economy's Phillips curve or aggregate supply function is of the expectational variety. Such a Phillips curve relationship could take the form

$$(1) \quad \log y_t - \log y_t^* = \alpha (\Delta \log P_t - E_{t-1} \Delta \log P_t)$$

$$+ \lambda (\log y_{t-1} - \log y_{t-1}^*)_t + \varepsilon_t$$

where ε_t is a purely random disturbance, y_t and y_t^* are actual and "capacity" or "natural rate" values of aggregate output for period t, and P_t is the aggregate price level. The $E_{t-1} \Delta \log P_t$ term in the equation denotes the expectation of $\Delta \log P_t$ (the inflation rate) held at the end of period t-1. According to equation (1), the inflation rate can be lowered without any deleterious effect on output relative to capacity, provided that the reduction in the inflation rate is correctly anticipated by at least one period. In other words, the output costs will be smaller, the smaller is the excess of expected over actual inflation rates during the disinflationary episode. While we could hypothesize rational expectations for the formation of E_{t-1} (.) in equation (1), that hypothesis is neither necessary nor sufficient for the credibility hypothesis. 2/

The conclusions of the credibility hypothesis, however, are considerably stronger in the context of the RE-MC model. In the RE-MC model, there is sufficient wage and price flexibility so that the short-run aggregate supply curve responds fully to changes in expectations about future policy. Thus, the announcement of a credible abrupt disinflation policy, where the aggregate demand curve remains fixed, will not cause any upward shift in the short-run aggregate supply curve. Hence, when the

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1/ See also Fellner (1979). Kydland and Prescott (1977) have a related analysis where they demonstrate that due to the dynamic inconsistency of accommodating policies, a credible non-accommodating policy may be consistent and optimal.

2/ See McCallum (1984).

anti-inflation policy is implemented, the inflation rate can be reduced with no output loss. 1/

The credibility hypothesis is also compatible with inertia in the inflation process. In Fellner's words: "Allowance needs to be made for a transition period during which lags in establishing credibility, as well as past contracts and their temporary influence on new contracts, would continue to slow the process of price deceleration" (1979, p. 169). Thus, Gordon (1983b) feels that the contribution of the credibility hypothesis mainly concerns the effect of credible policies in altering the public's behavior that creates inertia.

Recent attempts to demonstrate the validity of the RE-MC view and the importance of credibility (i.e., the hedged version of RE-MC) are Sargent's historical examples of rapid disinflation efforts in different countries. In the central European hyperinflations of the 1920s that Sargent (1982) studies, inflation was eliminated quickly with little apparent output loss. Sargent argues that a key characteristic of these successful cases of anti-inflation policy was the abrupt once-and-for-all fiscal reforms that were put in place. These fiscal reforms eliminated the huge budget deficits and ended rapid money growth, and since they reflected a drastic change in the policy regime or "rules of the game," the reforms were credible. 2/

Sargent's hyperinflation examples are meant to show that instantaneous adjustment is at least possible if drastic changes in policy are undertaken. However, many authors 3/ have criticized Sargent on the grounds that his examples are not relevant to more moderate inflations that have persisted for several years. These authors argue that one problem with hyperinflation examples is that most contractual or institutional rigidities break down during a hyperinflation and hence there are no impediments to quick price

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1/ See Mishkin (1984) for a graphical analysis of this point.

2/ While Sargent stresses sudden and drastic policy changes, Blanchard (1985) argues that an abrupt change in money growth may be self-defeating whereas slow deceleration may not. Blanchard's argument proceeds along the following lines. Disinflation policies may fail simply because they are expected to fail. A democratic government which attempts to reduce inflation by drastically lowering money growth may not succeed but may generate unemployment instead. The reason for the failure of the policy is that it may not be expected to remain in office long enough to maintain this lower rate of money growth. In turn, the reason why it may not be expected to remain in office is because of the high unemployment that its policy may generate. Blanchard argues that failure is less likely for mild disinflations and hence there is some support for gradualist policies.

3/ See, for example, Gordon (1983b) and Taylor (1983).

and wage adjustments. Recognizing this criticism Sargent (1983) examined the 1926 Poincare anti-inflation program in France. He shows that the moderate inflation that persisted since World War I stopped abruptly after fiscal reforms were instituted. 1/ Sargent also contends that the Poincare program was more successful than the recent Thatcher program in the U.K., because Poincare's program established credibility by pursuing budget reforms while Thatcher's program did not.

Numerous authors have studied the recent disinflationary experience in the U.S. in order to shed some light on whether credibility is an important factor for the success of an anti-inflation program. 2/ The overall conclusion that can be extracted from these studies is that the recent U.S. disinflationary episode cannot provide a test of the importance of credibility because a credible anti-inflation policy never occurred. One obvious reason why it is felt that the credibility of anti-inflation policy was never established is the emergence of historically large structural fiscal deficits. 3/

To conclude this discussion of the importance of credibility for the success of a disinflationary policy, it is worth quoting at length from the work of Arida and Lara-Resende (1985, p. 42): 4/

> "A credible change in economic policy can stop inertial inflation, but only under certain conditions. A three-fold taxonomy of inflation processes helps explain this connection. Low, one digit inflation differs from chronic two or three digit inflation, and the later in turn are different from open hyperinflation. In low, one digit inflation processes indexation mechanisms are not in place. In chronic inflationary processes, lagged or backward looking indexation clauses become widespread. In open hyperinflations, the shortening of the indexation period leads the economy to approximate the instantaneous indexation paradigm. The inertia created by long contracts which

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1/ Sargent did not examine the effects of the Poincare disinflation on the real economy. After reconsidering the facts, Taylor (1983) suggests that the recession following the disinflation was due to the disinflationary policies rather than other causes.

2/ See McCallum (1984) and Mishkin (1984) for summaries of these studies.

3/ Evidence from the Federal Republic of Germany provided by Artus (1981) also casts some doubts on the applicability of the RE-MC-credibility view. Artus shows that even if the sudden adoption of a new restrictive monetary policy is successful in changing expectations, the output loss is still likely to be substantial. A major reason for this effect is the one-year contractual wage arrangements in the Federal Republic of Germany.

4/ Yeager (1981) makes essentially the same point: it is easier to stop mild inflations and hyperinflations than merely intermediate ones.

> cause violent fluctuations in real contract values, as well as the inconsistency of relative prices at any given point in time, are eliminated in the later stages of hyperinflations. The memory of the economic system has already shrunk to a point at which past inflation once again becomes irrelevant. The nature of hyperinflations thus makes it possible to secure an abrupt halt to price increases solely through a credible change in economic policy. Credibility, however, is not a sufficient condition when inflation is still in its chronic, inertial two or three digit phase."

III. The Model

The model presented in this section is designed to empirically distinguish between the NRH-GAP view and the unhedged RE-MC view of the inflation process. The model, which was originally devised by Gordon (1982a), is not country specific and is general enough to be equally applicable to a wide variety of countries. 1/ One advantage of this approach is that it yields insights into similarities and differences across countries with respect to their experience with inflation. The obvious pitfall is that differences in institutional frameworks and macroeconomic and trade policies tend to be neglected.

The model is not designed to test for the importance of credibility and regime changes, per se. Rather, it is designed to determine the importance of the role of inertia in the inflation process, and to test whether the LSWB corollary is valid or not. The model, however, is not capable of determining or isolating the sources of inertia, if inertia is in fact present.

The model focuses on the LSWB corollary and the unhedged RE-MC view because it is extremely difficult to either verify or refute the hedged RE-MC view. This is due to the fact that it is not a trivial task to determine whether credibility or the "proper hypothetical conditions" were established. In Feldstein's words: "...the conditions needed for painless disinflation are never likely to hold; the [hedged RE-MC view] is essentially untestable by experience" [Feldstein (1985, p. 18)]. Therefore, the position taken in this paper is that if the unhedged RE-MC view can be empirically rejected, it would not necessarily imply that the

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1/ Alogoskoufis and Pissarides (1982) also present a model designed to test for the role of sluggishness in price adjustment. However, the problem with their model is that it yields a set of equations that are almost observationally equivalent, hence making it extremely difficult to distinguish between the alternative hypotheses.

hedged RE-MC position is invalid, but it would cast doubts on the veracity of the hedged position. In short, the model does not test for the effect of a credible change in the policy regime, the essence of the hedged RE-MC view, but rather, a fixed regime is assumed. 1/

Gordon (1979, 1982a) points out that an important flaw in Barro (1978) and other works testing the LSWB proposition and its corollary, is *that the estimated coefficients of prices and output* with respect to anticipated and unanticipated changes in money have been estimated in equations omitting velocity changes. In his words:

> "...Barro-Rush [1980] agents are assumed to be able to predict velocity with precise accuracy, while their uncanny predictive powers do not extend to perfect foresight about the money supply--thus only monetary surprises are included in their estimated output equation..."[Gordon (1979, p. 7)].

Formally, this procedure of using levels of or changes in the money supply as the only exogenous demand-shift variable requires the implicit assumption that changes in velocity have no systematic effect on prices or output, that is, that velocity is a random serially uncorrelated variable. The more general form of the model calls for prices and real output to depend on surprises in nominal GNP growth. This is the approach used in several papers by Gordon and also by Mishkin (1982), and it is adopted in this paper. Hence, the discussion is couched in terms of changes in nominal aggregate demand rather than changes in the money supply.

The NRH-GAP view predicts that an X percent fully anticipated deceleration in the growth of nominal aggregate demand will initially be reflected partly in slower inflation and partly in a temporary fall in real output below the natural level. Eventually, the process of gradual

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1/ In a pioneering paper Baxter (1985) develops and implements a method for measuring the 'credibility' of an announced policy reform. She defines 'credibility' to be the subjective probability, as assessed by agents in the economy, that the government is in fact following the announced 'reform' policy rule. The 'credibility' of a reform is a function of the parameters of both monetary and fiscal policies, and agents learn in a Bayesian fashion about the true parameters of government policy. Using Bayesian techniques Baxter calculates various measures of credibility associated with the Argentine and Chilean reforms of the late 1970s. However, she was not able to frame a rigorous statistical test of the hypothesis that credibility (or the lack thereof) 'causes' movements in the inflation rate, since movements in the inflation rate are not strictly exogenous with respect to the credibility variable in her model.

adjustment of prices will be completed and the inflation rate will fall by the full X percent amount, and real output will return to the natural level. The factors that prevent prices from falling instantaneously are, for example, backward looking or autoregressive expectations, indexation, adjustment and transactions costs of frequent price revisions, long-term contracts, decentralization and asynchronization of decision making and price setting, and government imposed price controls. These factors explain why the full adjustment of the inflation rate does not occur instantaneously.

According to Gordon (1982a, p. 1090), the real issue separating the RE-MC view from the NRH-GAP alternative is the importance of inertia in price adjustment: "for [RE-MC] to be true, there can be no inertia, whereas inertia is the essence of the alternative NRH-GAP approach." To empirically test the two hypotheses, he develops a reduced-form equaion for the inflation rate in which the unhedged RE-MC and NRH-GAP hypotheses appear as special cases. This allows coefficient estimates to distinguish the two. We now turn to a presentation of the Gordon (1982a) model.

Gordon begins with a Lucas aggregate supply function where the "output ratio" (log Q_t), defined as the difference between log output (y_t) and log natural output (y_t^*), depends on the unanticipated component of price change and on the lagged output ratio: 1/

$$(2) \quad \log Q_t = \log y_t - \log y_t^* = \alpha UP_t' + \lambda \log Q_{t-1} + \varepsilon_t$$

where P_t' represents the percentage rate of change of the price level, the prefix U stands for the difference between the realization of a variable and its expectation, and ε_t is a stochastic error term with mean zero and constant variance. Thus, $UP_t' = (P_t' - E_{t-1} P_t')$ stands for the unanticipated component of price change. Note that "state dependence" or "persistence effects" are introduced through the inclusion of a lagged output ratio variable on the right hand side of the equation.

The purpose now is to derive general equations for price adjustment that subsume the Lucas supply function (2) and the GAP approach as alternative special cases. To derive the implications of the Lucas supply function for the response of price change to anticipated changes in nominal aggregate demand, the simple identity linking the rate of price change (P_t') to the difference between the growth rates of nominal GNP (Y_t') and real GNP (y_t') may be used:

1/ Except for new notation, equation (2) is identical to the Phillips curve equation in Section II.

$$(3)\quad P_t' \equiv Y_t' - y_t'$$
$$\equiv \tilde{Y}_t' - \tilde{y}_t'$$

where the "tildes" in the second line denote that the indicated variables are measured net of the trend or natural growth rate of real GNP. Thus, $\tilde{y}_t'$, the deviation of actual output growth from natural output growth, is equal to the change in the log output ratio. That is, $y_t' \equiv \log Q_t - \log Q_{t-1}$.

Therefore, equation (3) is equivalent to

$$(4)\quad P_t' \equiv \tilde{Y}_t' - \log Q_t + \log Q_{t-1}$$

Rewriting (4) as a relationship between the unanticipated component of each variable, and noting that with a one period information lag the unanticipated component of the lagged output gap, $U \log Q_{t-1}$, is zero, we obtain

$$(4a)\quad UP_t' = UY_t' - U \log Q_t$$

Note that the unanticipated component of the right hand side of equation (2) is $\alpha\ UP_t' + \varepsilon_t$. Substituting this for $U \log Q_t$ in equation (4a) yields

$$(5)\quad UP_t' = \frac{1}{1+\alpha}(UY_t' - \varepsilon_t)$$

Substituting equation (5) into equation (2) we get the relationship between the actual output gap and the unanticipated component of nominal GNP change:

$$(6)\quad \log Q_t = \frac{1}{1+\alpha}(\alpha\, UY_t' + \varepsilon_t) + \lambda \log Q_{t-1}$$

Equation (6) expresses the view that the real GNP gap depends only on the unanticipated component of nominal demand changes and is not affected by the anticipated component. Thus, equation (6) may be considered to be a direct statement of the LSWB "policy ineffectiveness" proposition.

To obtain a related expression for price change, we first split actual nominal GNP change in identity (4) into its expected and unexpected components:

(4b) $P'_t \equiv E\tilde{Y}'_t + UY'_t - \log Q_t + \log Q_{t-1}$

Now, substituting equation (6) for the actual output gap, $\log Q_t$, in the above expression yields the price equation:

(7) $P'_t = E\tilde{Y}'_t + \frac{1}{1+\alpha}(UY'_t - \varepsilon_t) + (1 - \lambda) \log Q_{t-1}$

This equation states that the anticipated component of nominal demand change ($E\tilde{Y}'_t$) results completely in a price change, whereas the unanticipated component is divided between price and output change with respective weights $1/(1 + \alpha)$ and $\alpha/(1 + \alpha)$. Therefore, equation (7) is comparable with the corollary to the LSWB proposition and the unhedged *RE-MC view*.

Having outlined the RE-MC approach, we now turn to the alternative gradual price adjustment approach. Instead of beginning with the Lucas supply function (2), where the output ratio ($\log Q_t$) is the choice variable, the NRH-GAP approach starts with the determination of the rate of change of prices. Gordon assumes that the inflation rate deviates gradually from the inherited inflation rate in response to either demand or supply shocks. He represents the influence of demand on price adjustment by the level ($\log Q_t$) and change or acceleration ($\Delta \log Q_t$) of the output ratio, and represents the influence of supply by a vector of "supply shock" variables (S_t). The influence of inherited price change may be represented by a general lag distribution on past inflation to obtain

(8) $P'_t = a(L)P'_{t-1} + b_o \log Q_t + b_1 \Delta \log Q_t + b_2 S_t + e_t$

where $a(L)$ is a polynominal in the lag operator, and e_t is a serially independent error term with zero mean.

The theoretical underpinnings for the assumption of gradual price adjustment are given in Gordon (1981), and have been summarized in Section II. A derivation of equation (8) from a wage and price markup equation is contained in Gordon (1982b). It should be noted that equation (8) combines gradual price adjustment with long-run neutrality, if the sum of the $a(L)$ coefficients is unity, since in this case the rate of price change remains constant when real output is equal to natural output ($\log Q_t = 0$) and when there are no supply shocks ($S_t = 0$). 1/

1/ These long-run neutrality restrictions were not imposed when the model was estimated.

To convert equation (8) into a form that is directly comparable with the RE-MC price-change equation (7), we can rewrite identity (4b) as

$$(4c)\quad \log Q_t \equiv E\tilde{Y}_t' + UY_t' - P_t' + \log Q_{t-1}$$

Substituting (4c) for $\log Q_t$ in (8) we obtain the following price equation:

$$(9)\quad P_t' = \frac{1}{1 + b_o + b_1}\left[a(L)P_{t-1}' + (b_o + b_1)(E\tilde{Y}_t' + UY_t') + b_o \log Q_{t-1} + b_2 S_t + e_t\right]$$

While equations (7) and (9) have three variables in common, $E\tilde{Y}_t'$, UY_t' and $\log Q_{t-1}$, they display several important differences. These differences are more evident if we rewrite equation (9) in its estimable form:

$$(10)\quad P_t' = c(L)P_{t-1}' + d_o E\tilde{Y}_t' + d_1 UY_t' + d_2 \log Q_{t-1} + d_3 S_t + u_t$$

Now it is evident that the RE-MC price equation (7) is just a special case of the GAP price equation (10) which places explicit restrictions on coefficient estimates. These restrictions are summarized in the following table where $\sum a_i$ and $\sum c_i$ refer to the respective sums of the a(L) and c(L) lag coefficients.

Variable	Coefficient in NRH-GAP Hypothesis	Coefficient in in Special RE-MC Case
P_{t-1}'	$\sum c_i = \frac{\sum a_i}{1 + b_o + b_1} > 0$	$\sum c_i = 0$
$E\tilde{Y}_t'$	$d_o = \frac{b_o + b_1}{1 + b_0 + b_1} < 1$	$d_o = 1$
UY_t'	$d_1 = \frac{b_o + b_1}{1 + b_o + b_1} < 1$	$d_1 = \frac{1}{1 + \alpha} < 1$
$\log Q_{t-1}$	$d_2 = \frac{b_o}{1 + b_o + b_1} < 1$	$d_2 = 1 - \lambda < 1$

The three important differences between the gradual price adjustment equation (10) and the LSWB corollary equation (7) are as follows according to Gordon (1982a, pp. 1093-1094).

> "First, since price inertia is the antithesis of the [LSWB] proposition, the sum of coefficients on lagged price change in [7] is zero, whereas the sum is positive in [10]. Second, the [LSWB] equation [7] implies that the elasticity of price change to an anticipated change in nominal demand is exactly unity, with other determinants of output held constant, whereas that coefficient must be less than unity in [10] if the sum of the level and rate of change coefficients for the output terms in equation [8] is positive ($b_0 + b_1 > 0$). Finally, the coefficient on unanticipated demand changes in the [LSWB] equation must be less than the unitary response to anticipated changes, whereas in the alternative approach the response of prices to anticipated and unanticipated changes is identical."

Since the estimated coefficient on the lagged output ratio is predicted to be less than unity in both approaches, these coefficient estimates cannot be used to distinguish the two approaches. Also, while a vector of supply shock variables appears in equation (10) but not in equation (7), this is not an important difference since supply shocks could also be explicitly modeled in the RE-MC approach. 1/

To summarize, a single empirical equation explaining the inflation rate was presented in this section. This equation includes the LSWB corollary and the alternative NRH-GAP hypothesis as special cases, and coefficient estimates can then distinguish between the two alternatives.

IV. The GNP Prediction Equation and Other Estimation Issues

One of the main practical estimation problems in the model outlined above is the decomposition of nominal GNP growth into its anticipated and unanticipated components. Tests of the model hinge on forming accurate proxies for anticipated and unanticipated nominal GNP changes. While the GNP prediction equation is the primary focus of this section, other important estimation issues are also discussed.

1/ To obtain the equation for the output ratio that is consistent with the NRH-GAP formulation, that is, to obtain the "dual" of equation (10), we can substitute the right hand side of (10) for P'_t in identity (4c). This yields the following equation for the output ratio

$$\log Q_t = -c(L)P'_{t-1} + (1-d_0)E\tilde{Y}'_t + (1-d_1)\,UY'_t + (1-d_2)\log Q_{t-1} - d_3 S_t - u_t$$

Before continuing further, some caveats are in order. First, poor specification is always a danger in this line of research. If the researcher erroneously omits a variable actually used to forecast nominal GNP growth from his GNP prediction equation, part of researcher's estimate of unanticiated nominal GNP is really anticipated. On the other hand, the researcher may use a predictor of anticipated GNP growth that is not actually employed by economic agents in their true GNP prediction equation. In this case, part of the researcher's anticipated GNP growth is really unanticipated. Thus, unless the nominal GNP growth process is modelled exactly, the proxies for anticipated and unanticipated GNP growth will include a measurement error. Such misspecification will lead to an errors-in-variables bias in the coefficients of the inflation rate equation.

Second, all the tests conducted are conditioned on the maintained hypothesis that nominal GNP is exogenous. For identification of the model it is necessary to assume that all right-hand side variables in equation (10), including nominal GNP, are exogenous. The assumption that nominal GNP is exogenous is more tenuous than would be the case if money growth was the aggregate demand variable. As Mishkin (1982, p. 789) states:

> "Although the exogeneity of money growth...is by no means uncontroversial, economists are more willing to assume the exogeneity of money growth than the exogeneity of nominal GNP growth..."

In any case, it is a maintained hypothesis in this paper that nominal GNP is exogenous. This maintained hypothesis is explicit in Mishkin (1982), who also tests the LSWB proposition using nominal GNP as the aggregate demand variable, and is implicit in Gordon (1982a). Also, Lucas (1973) used nominal GNP as the aggregate demand variable in a paper that is by now a classic. 1/

Third, the α parameter in equation (7) is not a policy invariant parameter. The estimation procedure used in this paper does not take this into account. Hence, the results may be subject to the Lucas (1976) critique. In other words, for estimation purposes, a fixed policy regime is assumed in this paper. These caveats should be borne in mind when interpreting the results presented in the next section.

Economic agents' expectations of nominal GNP growth are assumed to be formed rationally. That is, expectations of nominal GNP growth are

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1/ The assumption that nominal GNP is exogenous implies that the aggregate demand curve must be unit elastic. See Demery (1984) for a discussion of some "awkward econometric difficulties" that arise due to this maintained hypothesis.

assumed to be equivalent to optimal, one-period-ahead forecasts, conditional on available information. Strictly speaking, the use of rational expectations requires that expectations be related to the underlying macroeconomic structure. However, this is empirically quite intractable. Therefore, most researchers in this area follow Sargent (1973) and attempt to satisfy the key property of rationality: orthogonality of expectational errors to the variables in the information set. This is the approach used in this paper.

The assumption of rational expectations implies the condition

$$(11)\quad E\tilde{Y}'_t = E(\tilde{Y}'_t/\Omega) = \tilde{Y}'_t - \gamma$$

Where $E(\tilde{Y}'_t/\Omega)$ denotes the expectation of $\tilde{Y}'_t$ conditional on the past values of a set of variables included in the information set Ω, and γ is a random term orthogonal to Ω i.e., $E(\gamma/\Omega) = 0$. (The specific composition of Ω will be discussed later in this section.) Under the assumption that the conditional expectation in equation (11) is linear, it follows that

$$(12)\quad E(\tilde{Y}'_t/\Omega) = \theta\Omega$$

and hence

$$(13)\quad \tilde{Y}'_t = \theta\Omega + \gamma$$

where θ is a vector of regression coefficients conformable to Ω. That is, $E\tilde{Y}'_t$ is in effect formed as the prediction from a linear regression of Y'_t on Ω.

Equations (10) and (13) may be estimated separately in a two-step procedure using ordinary least squares. In the first step, the GNP prediction equation with actual nominal GNP as the dependent variable is estimated. The fitted values of this equation are used as a proxy for $E\tilde{Y}'_t$ and the residuals are used as a proxy for UY'_t, in the second-stage equation explaining the inflation rate. Assuming serially independent errors and no omitted variables in the GNP prediction equation, this two-step procedure yields consistent estimates of the models parameters.

However, it is obvious that the parameters of equations (10) and (13) are related. If no account is taken of these cross-equation restrictions, the two-step procedure yields consistent but inefficient parameter estimates. Therefore, stronger tests of the model could be performed in

the context of a simultaneous equation framework, i.e., by estimating the forecasting equation for nominal GNP growth and the model for the inflation rate at the same time, and testing the implicit cross-equation restrictions. In other words, a joint estimation procedure, such as full information maximum likelihood (FIML), could be used to test whether invalid restrictions have been forced on the model's structure and to generate more efficient estimates of the parameters of the model.

Unfortunately, in spite of its theoretical superiority over the two-step estimation procedure, a FIML procedure with cross equation constraints imposed is not used in this paper because of the short data spans available for the countries being studied. Hence, only the two-step, single equation estimation procedure is used.

Another econometric issue is the observational equivalence problem, first posed by Sargent (1976). Consider the following Lucas supply function in place of equation (6):

$$(14)\quad \log Q_t = \sum_{i=o}^{n} \beta_i \, UY'_{t-i} + \epsilon_t$$

The problem is evident when anticipated nominal GNP growth depends only on lagged actual changes in GNP growth. Substitution of these lagged values of GNP growth into equation (14) would make output depend only on current and lagged changes in actual GNP growth. In this case, there is no way to distinguish between the hypothesis that unanticipated aggregate demand growth is important for the determination of output, and the alternative hypothesis that the actual growth rate of nominal demand during the current and previous periods is what influences output.

It is necessary, therefore, to impose a priori identifying restrictions on the model. Most researchers in this area [e.g., Barro (1978), Barro and Rush (1980), and Mishkin (1982)], have attempted to identify coefficients in the price and output equations by constraining particular variables to influence nominal aggregate demand growth but not to affect prices and output directly. That is, the problem of observational equivalence and identification can be overcome if the nominal GNP growth equation includes lagged values of at least one other variable besides GNP growth which does not enter the inflation rate equation separately. 1/

1/ See Buiter (1983) for a rigorous discussion of the identification problems in models that emphasize the effect of unanticipated aggregate demand changes on real output.

The observational equivalence problem can also be overcome by excluding lagged values of UY_t' from the output equation and hence excluding lagged aggregate demand shocks from the price change equation as well. This method is due to McCallum (1979) and is adopted in this paper. One of the factors that argue for the exclusion of lagged demand shocks from influencing prices and output directly is McCallum's point that "it is hard to imagine ways in which past expectational errors could have direct effects on current behavior--bygones are, after all, bygones" [McCallum (1979, p. 398)]. 1/ To introduce persistence effects, therefore, the lagged output ratio is entered into the Lucas aggregate supply function (2).

We now turn to the equations used to predict nominal GNP in the 13 countries being studied. The main issue is the selection of variables that should enter the information set Ω in equation (13). Unfortunately, economic theory is not very valuable in generating an accurate model of expectations formation because it is difficult on theoretical grounds to exclude any piece of information available at time t-1 as a useful predictor of nominal GNP growth. Therefore, an atheoretical statistical procedure, rather than economic theory, was used for deciding on the nominal GNP growth equation specification. The procedure used amounts to running a series of bivariate Granger tests of predictability. 2/ To implement the procedure, the annual nominal GNP growth rates in the 13 countries were regressed on their own two lagged values as well as two lagged values of a potential explanatory variable. Several potential explanatory variables were considered, and a separate bivariate autoregression was estimated for each of the potential explanatory variables. A wide ranging set of domestic and international macroeconomic variables were considered as potential explanatory variables and they are presented below. 3/

(1) The growth rate of narrow money,

(2) the growth rate of broad money,

(3) the inflation rate,

(4) the growth rate of nominal government expenditures,

(5) the growth rate of real government expenditures,

1/ It should be noted that models have been developed to explain the persisting output effect of aggregate demand shocks. See, for example, Lucas (1975) and Blinder and Fischer (1981).

2/ Note that the issue is "predictability" rather than "causality." It is the former that the Granger (1969) tests are truly designed to analyze. The procedure used here is akin to that found in Mishkin (1982).

3/ Data for all of the potential explanatory variables were not available for some of the 13 countries studied. See the Appendix for details.

(6) the growth rate of nominal capital formation,

(7) the growth rate of real capital formation,

(8) the fiscal balance,

(9) the growth rate of real GNP,

(10) the growth rate of nominal exports,

(11) the growth rate of real exports,

(12) the rate of change of the nominal exchange rate,

(13) the rate of change of the real exchange rate, 1/

(14) the current account balance,

(15) the rate of change of the terms of trade,

(16) the growth rate of world narrow money, and

(17) the growth rate of real income in industrial countries.

The series of bivariate autoregressions yielded F-statistics for the joint tests for significant explanatory power of two lagged values of each of the variables in the list of potential explanatory variables. The following decision rules were then applied. Variables for which two lagged values were jointly significant at the 5 percent level or higher were retained as potential explanatory variables while the rest were discarded. In cases where two variables were related to each other, such as the growth rates of narrow and broad money, or the growth rates of nominal and real exports, and both had significant explanatory power, the one that produced the lower standard error of the equation was chosen. 2/ Finally, in the interest of parsimonious estimation, in cases where more than one unrelated variable had significant explanatory power when considered individually, the final specification was arrived at by running unrestricted regressions that contained all of these significant variables, and then paring the specification down by eliminating variables that no longer had

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1/ The real exchange rate was measured simply as product of the nominal exchange rate and the U.S. GNP deflator divided by the domestic price level.

2/ In all cases, the variable that produced the lower standard error of the equation, was also the variable that yielded the higher F-statistic for joint explanatory power.

significant explanatory power when compared with restricted regressions. This implies that when two explanatory variables (besides lagged nominal GNP growth) appear in the final specification, each has significant explanatory power after allowing for the effect of the other variable on nominal GNP growth.

In short, if a variable helped Granger predict nominal GNP growth, it was included in the information set. While it could be argued that there is a fair amount of "ad hoccery" in this procedure, its advantage is that it imposes on the researcher the discipline of being prevented from searching for a different specification of nominal GNP growth, so as to produce results that confirm the researcher's priors on the hypotheses being tested.

The final equations predicting nominal GNP growth for each of the 13 countries are reported in Table 1. It is important that the method of formulation of expectations be such that it generates serially uncorrelated errors. Correlation in the residuals means that inspection of previous errors can contribute to improving the current predictions, and it is assumed that such an error learning process is costless and will therefore be undertaken without delay. The test for white noise residuals used in this paper involved an examination of the residual's autocorrelation function. The pertinent F-statistics for testing the hypothesis of white noise residuals, using fourth order residuals' autoregressions are also reported in Table 1. These F-statistics are below their critical values, indicating that in all countries the residuals from the nominal GNP growth equations are white noise. This means that these residuals are appropriate candidates for the measure of unanticipated nominal GNP growth.

From Table 1 it is clear that the final nominal GNP prediction equations have a fairly high degree of explanatory power in all countries except India and Korea. Also, it is interesting to note that the growth rate of world narrow money appears in the information set for 7 out of 13 countries. This may be due to the fixed or managed floating exchange rate regimes prevalent in these countries.

We now turn to the stability of the parameters of the GNP prediction equations. The samples were split at their midpoint and the equations were re-estimated for each half of the sample period. The test statistic for the equality between the sets of coefficients in the two regressions, described in Chow (1960), was calculated for each country. These test statistics were below their critical values in all cases, indicating that

Table 1: Nominal GNP Prediction Equations 1/

$$Y'_t = \theta_0 + \theta_1 Y'_{t-1} + \theta_2 Y'_{t-2} + \theta_3 X_{t-1} + \theta_4 X_{t-2} + \theta_5 Z_{t-1} + \theta_6 Z_{t-2}$$

Country and Period	θ_0	θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	R^2	X,Z 2/	F Statistic for Residuals
Brazil	0.114	0.835	-0.341	0.001	0.015	-0.474	-0.027	0.851	X = FB	F (4, 13) =
1961-1982	(3.658)	(4.408)	(1.855)	(0.045)	(2.904)	(2.668)	(0.132)		Z = GRCF	0.146
Colombia	0.029	-0.116	-0.203	0.005	0.004	--	--	0.690	X = GWM1	F (4, 20) =
1954-1982	(2.867)	(0.596)	(1.138)	(2.228)	(1.702)					0.250
Greece	0.006	0.235	0.037	0.003	0.001	--	--	0.661	X = GWM1	F (4, 21) =
1954-1983	(0.773)	(1.779)	(0.286)	(1.776)	(0.502)					1.501
India	0.012	-0.083	-0.113	0.004	0.0005	--	--	0.275	X = GWM1	F (4, 20) =
1954-1982	(0.978)	(0.397)	(0.628)	(1.268)	(0.162)					0.530
Israel	-0.021	0.282	-0.004	0.689	0.160	--	--	0.945	X = GM2	F (4, 20) =
1955-1983	(1.942)	(1.109)	(0.022)	(4.088)	(0.831)					1.987
Korea	0.052	0.567	-0.126	-0.074	0.177	--	--	0.412	X = GREXR	F (4, 18) =
1957-1983	(2.487)	(2.823)	(0.319)	(0.832)	(2.460)					1.424
Malaysia	-0.008	-0.172	-0.202	0.012	-0.005	--	--	0.522	X = GWM1	F (4, 17) =
1958-1983	(0.525)	(0.849)	(1.077)	(3.514)	(1.243)					1.358
Mexico	0.012	0.205	-0.062	-0.3 3/	0.2 3/	0.597	0.077	0.878	X = CAB	F (4, 19) =
1955-1982	(1.100)	(0.981)	(0.388)	(1.237)	(0.397)	(3.046)	(0.333)		Z = GM1	0.804
Peru	0.011	0.451	0.359	0.335	-0.056	--	--	0.902	X = GEXR	F (4, 22) =
1953-1983	(1.279)	(2.527)	(2.395)	(3.778)	(0.532)					0.590
Philippines	0.007	0.307	-0.340	0.005	0.001	--	--	0.561	X = GWM1	F (4, 22) =
1953-1983	(0.727)	(1.670)	(1.860)	(2.183)	(0.352)					0.499
Portugal	-0.012	0.283	-0.069	0.007	-0.001	--	--	0.846	X = GWM1	F (4, 20) =
1955-1983	(1.528)	(1.397)	(0.460)	(4.814)	(0.596)					1.363
Thailand 4/	0.008	0.143	-0.221	-0.265	0.007	-0.001	--	0.701	X = GWM1	F (4, 21) =
1954-1983	(0.921)	(0.772)	(1.348)	(1.816)	(3.578)	(0.505)				1.843
Turkey	-0.009	0.011	-0.044	0.7 3/	-0.3 3/	--	--	0.687	X = CAB	F (4, 17) =
1958-1983	(0.005)	(5.176)	(0.160)	(2.659)	(1.898)					0.249

1/ Figures in parentheses are absolute values of t-statistics.

2/ FB = fiscal balance; GRCF = growth rate of real capital formation; GWM1 = growth rate of world narrow money; GM1 = growth rate of narrow money; GM2 = growth rate of broad money; GREXR = rate of change of the real exchange rate; GEXR = rate of change of the nominal exchange rate; CAB = current account balance; GRYIC = growth rate of real income in industrial countries.

3/ These values should be multiplied by 10^{-6}.

4/ For Thailand, a third lag on the dependent variable was necessary to produce white noise noise residuals. Therefore, the θ_3 coefficient is for Y'_{t-3}, and the θ_4 and θ_5 coefficient are for X_{t-1} and X_{t-2}, respectively.

the parameters of the GNP prediction equations in Table 1 are indeed stable given the break points chosen. 1/

Another estimation issue is the selection of proxy variables to represent systematic supply shocks (S_t) in the inflation rate equation (10). Among the candidates are changes in the relative prices of food and energy, government intervention in the form of price controls, changes in the foreign exchange rate, and the influence of foreign prices on domestic prices. However, data availability limits the choice of supply shock variables that can be used in this study.

The role of import prices as a separate source of inflation in small open developing countries has been stressed by, among others, Dornbusch and Fischer (1981) and Bhalla (1981). In a world of fixed exchange rates, or if authorities are reluctant to undertake large adjustments in their exchange rates even when there is a substantial difference between domestic and foreign rates of inflation, external inflation may have a primary role in causing domestic inflation. Therefore, for empirical application of the inflation rate equation (10), the only supply shock considered was changes in import prices, denoted by PM'_t. 2/ 3/

Finally, for empirical application of the inflation rate equation, the number of lagged inflation rate terms included to capture price inertia was arbitrarily set at 3. These lagged inflation rate terms were estimated freely without imposing any restrictions.

V. The Empirical Results

In the previous section we undertook the first step of the estimation process--obtaining proxies for anticipated and unanticipated nominal GNP

1/ The test statistics were as follows: Brazil , F (7, 8) = 2.020; Colombia, F (5, 19) = 0.909; Greece, F (5, 20) = 1.387; India, F (5, 19) = 0.838; Israel, F (5, 19) = 1.267; Korea, F (5, 17) = 1.161; Malaysia, F (5, 16) = 1.309; Mexico, F (7, 14) = 1.633; Peru, F (5, 21) = 0.644; the Philippines, F (5, 21) = 0.355; Portugal, F (5, 19) = 0.852; Thailand, F (6, 18) = 0.991; and Turkey F (5, 16) = 2.796.

2/ It should be pointed out that the use of import price changes as the supply shock variable may introduce a multicollinearity problem that leads to larger standard errors of the coefficients. Therefore, the estimation was also carried out without this variable, and the results reported in the next section were not qualitatively affected.

3/ A series for import prices was not available for all the countries being studied. Therefore, the CPI in industrial countries was used as a proxy in some of the countries. See the Data Appendix for details.

growth from the GNP prediction equations. Now, in this section, in the second step of the estimation process, we use these proxies in the inflation rate equation derived in Section III. The equation to be estimated is repeated here for convenience.

$$(10) \quad P'_t = c(L)P'_{t-1} + d_o \tilde{EY}'_t + d_1 UY'_t + d_2 \log Q_{t-1} + d_3 PM'_t + u_t$$

It was shown that the unhedged RE-MC inflation rate equation (7) is just a special case of this equation which places explicit restrictions on coefficient estimates. Therefore, the test procedure is based on the different predictions made by the RE-MC and NRH-GAP hypotheses regarding two sets of coefficients . The LSWB corollary predicts that the coefficient on anticipated nominal GNP change will be unity, and that the sum of the coefficients on lagged price change will be zero. In contrast the NRH-GAP hypothesis predicts that the coefficient on $\tilde{EY}'_t$ will be less than unity, and that the sum of coefficients on lagged price change will be positive.

The estimates of the inflation rate equation using the two-step, single-equation estimation procedure are presented in Table 2. Before concentrating on the coefficients that distinguish between the RE-MC and NRH-GAP hypotheses, several general observations are in order. First, judging from the adjusted coefficients of determination, $\bar{R}^2$, the data from all countries fit the model quite well. The range of $\bar{R}^2$ is from 0.75 for Korea to 0.99 for Israel, with most of the values clustered around 0.85 to 0.95.

Second, based on the Durbin h statistic, there is no evidence of significant first-order serial correlation of the residuals in any of the countries. 1/ For Greece and Peru, the formula for the Durbin h statistic produced an imaginary result. Therefore, an alternative test for first-order serial correlation suggested by Durbin (1970) was conducted. This test involves the least squares fitting of the regression of the residuals on lagged residuals and also the other variables that enter the inflation rate equation. The test for first-order serial correlation now involves testing the null hypothesis that the coefficient on the lagged residual is not significantly different from zero. If we reject this null hypothesis, we conclude that first-order serial correlation is present. Applying this test, the null hypothesis of no first-order serial correlation of the residuals cannot be rejected even in the countries with imaginary Durbin h statistics.

1/ In Malaysia and Thailand, however, it was necessary to use the Cochrane-Orcutt estimation procedure to purge first-order serial correlation.

Table 2: Estimates of Reduced Form Inflation Rate Equation 1/

$$P'_t = c(L)\, P'_{t-1} + d_o\, E\tilde{Y}'_t + d_1\, UY'_t + d_2 \log Q_{t-1} + d_3\, PM'_t$$

Country and Period	Constant	$\sum_{i=1}^{3} c_i$	d_o 2/	d_1	d_2	d_3	$\bar{R}^2$	SEE	Durbin h	Test for $c_1=c_2=c_3=0$
Brazil 1961-1982	-0.003 (0.115)	0.504 (4.165)	0.247 (3.112)	0.424 (2.031)	0.369 (2.427)	0.222 (1.754)	0.935	0.020	-1.611	F (3, 14) = 5.929
Colombia 1954-1982	-0.014 (2.478)	0.238 (2.454)	0.683 (2.882)	0.839 (8.068)	0.176 (1.701)	0.094 (2.969)	0.926	0.008	1.197	F (3, 21) = 2.000
Greece 1954-1983	-0.024 (2.417)	0.015 (0.644)	0.803 (0.798)	0.380 (2.729)	-0.150 (1.558)	0.292 (3.155)	0.902	0.009	Imaginary 3/ -0.213 (0.636)	F (3, 22) = 0.495
India 1954-1982	0.004 (0.646)	0.528 (4.552)	0.081 (5.106)	0.557 (6.066)	0.898 (6.801)	0.241 (4.971)	0.896	0.009	1.607	F (3, 21) = 9.333
Israel 1955-1983	-0.033 (5.075)	0.468 (3.656)	0.704 (2.530)	0.968 (9.562)	0.163 (2.639)	0.002 (0.108)	0.989	0.013	0.592	F (3, 21) = 5.250
Korea 1957-1983	-0.004 (0.267)	-0.120 (0.727)	0.752 (1.356)	0.538 (4.006)	0.168 (1.802)	0.103 (1.495)	0.746	0.016	0.857	F (3, 19) = 1.164
Malaysia 1958-1983	-0.005 (1.230)	0.392 (3.111)	0.231 (6.689)	0.074 (0.732)	0.070 (1.134)	0.217 (2.659)	0.817	0.009	-0.999 4/	F (3, 17) = 11.289
Mexico 1955-1982	-0.024 (6.975)	0.093 (0.903)	0.802 (2.176)	0.619 (5.404)	0.437 (3.070)	0.167 (5.713)	0.978	0.007	0.614	F (3, 20) = 0.417
Peru 1953-1983	-0.028 (3.090)	0.104 (0.441)	0.875 (0.436)	0.584 (4.818)	0.123 (1.216)	0.205 (4.302)	0.973	0.014	Imaginary 3/ 0.068 (0.182)	F (3, 23) = 1.460
Philippines 1953-1983	-0.019 (3.707)	0.155 (1.490)	0.801 (1.453)	0.741 (8.256)	0.135 (1.078)	0.043 (1.764)	0.942	0.007	1.394	F (3, 23) = 0.925
Portugal 1955-1983	0.009 (1.706)	0.832 (6.551)	-0.121 (6.406)	-0.027 (0.163)	0.202 (3.282)	0.272 (4.938)	0.948	0.008	-0.036	F (3, 21) = 15.795
Thailand 1954-1983	-0.016 (2.579)	-0.037 (0.296)	0.712 (2.341)	0.623 (5.925)	0.154 (1.146)	0.132 (2.276)	0.833	0.008	0.871 4/	F (3, 21) = 0.248
Turkey 1953-1983	-0.029 (4.351)	0.040 (0.455)	0.968 (0.273)	0.998 (13.229)	0.118 (0.927)	0.715 (2.345)	0.970	0.012	0.123	F (3, 18) = 0.273

1/ Figures in parentheses are absolute values of t-statistics.
2/ t-statistic is for difference from unity.
3/ The numbers presented are the coefficient (and the absolute value of the t-statistic) on the lagged residual term in the alternative test for first-order serial correlation described in the text.
4/ After a Cochrane-Orcutt correction for first-order serial correlation.

Third, the coefficient on unanticipated nominal GNP growth (UY'_t) is significant in all countries except Brazil, Malaysia, and Portugal. 1/ Also, the coefficient on the lagged output ratio, log Q_{t-1}, is significant in five out of thirteen countries. And finally, the coefficient on the import price change term is significant in nine out of thirteen countries.

Turning now to the role of inertia in the determination of the inflation rate, the sum of the lagged inflation rate terms is significantly different from zero in six countries: Brazil, Colombia, India, Israel, Malaysia, and Portugal. An additional test for the irrelevance of lagged price changes in the inflation rate equation was also carried out. This test involved running a regression that excluded these lagged price change terms and comparing the sum of squared residuals of this regression with the sum of squared residuals of the original regression that includes the lagged price change terms. This test for joint significance of the lagged price change terms yields a test statistic that has an F-distribution. An F-statistic greater than the critical value implies a rejection of the null hypothesis that the lagged price change terms are not jointly significant. The results of this test for joint significance are reported in the last column of Table 2. 2/ These results generally confirm the earlier conclusion based on the significance of the sum of the lagged inflation rate terms: inertia is important in the determination of the inflation rate in Brazil, India, Israel, Malaysia, and Portugal. Colombia is the anomaly in the group since the sum of the lagged inflation terms is significantly different from zero, but the hypothesis that these terms are not jointly significant cannot be rejected.

Concerning the coefficients on anticipated nominal GNP change ($\tilde{EY}'_t$), Table 2 reports t-statistics that test the null hypothesis that these coefficients are equal to unity. 3/ A t-statistic below the critical value implies that the null hypothesis cannot be rejected. As can be seen from Table 2, the coefficient on anticipated nominal GNP change is significantly different from unity in Brazil, Colombia, India, Israel, Malaysia, Mexico, Portugal, and Thailand. Except for Mexico and Thailand, this is the same group of countries for which there was evidence of inertia.

1/ All the significance tests in this section were conducted at at least the 5 percent significance level.

2/ These F-statistics, however, may not be particularly meaningful since a two-step estimation procedure is used. Hence it is implicitly assumed that the parameters in the first step are exact.

3/ The unreported t-statistics for the significance of the d_o coefficient show that except for Brazil, India, Malaysia, and Portugal, d_o is significantly greater than zero.

The results of the tests of hypotheses concerning the coefficient estimates are summarized in Table 3 for convenience. Overall, the results indicate that the unhedged RE-MC hypothesis cannot be rejected in five of the thirteen countries: Greece, Korea, Peru, the Philippines, and Turkey. That is, in these countries the coefficient estimates conform to the LSWB corollary that the inflation rate responds equiproportionately and contemporaneously to an anticipated change in nominal aggregate demand. Correspondingly, the unhedged RE-MC hypothesis can be rejected in 6 of the 13 countries: Brazil, Colombia, 1/ India, Israel, Malaysia, and Portugal. In these countries the alternative NRH-GAP hypothesis cannot be rejected since inertia has an important role in the inflation process. The results for Mexico and Thailand are ambiguous and inconclusive since the lagged inflation coefficients conform to the predictions of the LSWB corollary, while the anticipated nominal GNP growth coefficients conform to the predictions of the NRH-GAP hypothesis.

The mixed results should come as no surprise given the diversity of countries in the sample. As noted earlier, it is beyond the scope of this paper to give a rigorous explanation of why the speed of adjustment of inflation differs across the countries studied. Detailed research into the institutional and cultural features of these economies is necessary in order to provide an adequate explanation for the differences. Therefore, suffice it to say that the role of inertia is highly important in six of the countries studied, and the inflation rate adjusts quite slowly in these countries.

It is imperative to note, however, that given the manner in which the inflation rate equation and the alternative hypotheses are specified, it is only possible to reject the RE-MC hypothesis and not the NRH-GAP hypothesis. That is, the conclusion "cannot reject RE-MC" in Table 3 may also be consistent with NRH-GAP. 2/

VI. Summary and Conclusions

This paper addressed the question of whether the inflation rate adjusts rapidly or sluggishly to changes in nominal aggregate demand.

1/ The rejection of the RE-MC hypothesis in Colombia is based on the fact that the sum of the lagged inflation terms is significantly positive and the d_o coefficient is less than unity, even though the lagged inflation terms are not jointly significant. As noted earlier, F-statistics for joint significance may not be particularly meaningful.

2/ Ninety-five percent confidence intervals for Σc_i and d_o for the countries in which RE-MC cannot be rejected show that the former intervals are not tight around zero and that the latter intervals are not tight around unity.

Table 3. Summary of Tests of Hypotheses 1/

Country	H_o: $\Sigma c_i = 0$	H_o: $c_1 = c_2 = c_3 = 0$	H_o: $d_o = 1$	Conclusion
Brazil	Reject H_o	Reject H_o	Reject H_o	Reject RE-MC
Colombia	Reject H_o	Cannot reject H_o	Reject H_o	Reject RE-MC
Greece	Cannot reject H_o	Cannot reject H_o	Cannot reject H_o	Cannot reject RE-MC
India	Reject H_o	Reject H_o	Reject H_o	Reject RE-MC
Israel	Reject H_o	Reject H_o	Reject H_o	Reject RE-MC
Korea	Cannot reject H_o	Cannot reject H_o	Cannot reject H_o	Cannot reject RE-MC
Malaysia	Reject H_o	Reject H_o	Reject H_o	Reject RE-MC
Mexico	Cannot reject H_o	Cannot reject H_o	Reject H_o	Ambiguous
Peru	Cannot reject H_o	Cannot reject H_o	Cannot reject H_o	Cannot reject RE-MC
Philippines	Cannot reject H_o	Cannot reject H_o	Cannot reject H_o	Cannot reject RE-MC
Portugal	Reject H_o	Reject H_o	Reject H_o	Reject RE-MC
Thailand	Cannot reject H_o	Cannot reject H_o	Reject H_o	Ambiguous
Turkey	Cannot reject H_o	Cannot reject H_o	Cannot reject H_o	Cannot reject RE-MC

1/ The tests of hypotheses were conducted at the 5 percent significance level.

The answer to this question is crucial for determining the scope and cost of anti-inflation demand policies. The focus was on a general cross-country analysis, rather than detailed individual country studies. It was not the intention to provide precise numerical measures of the speed of adjustment of the inflation rate. Rather, in order to determine the speed of adjustment of the inflation rate to the rate of change of aggregate demand, two alternative hypotheses were considered: the RE-MC hypothesis and the NRH-GAP hypothesis. According to the NRH-GAP hypothesis, prices respond gradually in the short run and fully in the long run to nominal aggregate demand disturbances, whether anticipated or not, implying that the short run output cost of disinflation could be substantial. And, according to the unhedged RE-MC hypothesis, which is based on the LSWB corollary, prices move equiproportionately and instantaneously with anticipated changes in nominal aggregate demand, implying that an expected disinflation could reduce inflation quickly with no loss of output.

The empirical results of the tests of the two hypotheses were as follows. The RE-MC hypothesis could be rejected in favor of the NRH-GAP hypothesis in 6 of the 13 countries (Brazil, Colombia, India, Israel, Malaysia, and Portugal) since the role of inertia was significant. The results for Mexico and Thailand were inconclusive. In the remaining five countries (Greece, Korea, Peru, the Philippines, and Turkey) the RE-MC hypothesis could not be rejected.

Given the mixed empirical results, it is difficult to draw an overall conclusion for this paper. The results do offer support, though, for the view that inflation may persist due to inertia, even if the anti-inflation demand policy is anticipated. Thus the control of inflation may be achieved achieved only at the cost of a loss in output since the speed of adjustment of the inflation rate may be slow rather than instantaneous. This conclusion is fairly orthodox and is neither novel or original. Nevertheless, it casts doubts on Sargent's recent optimistic, but well hedged, assertions regarding the quick and painless control of inflation. Even in the countries where the RE-MC hypothesis could not be rejected, one cannot conclude that the output cost of anti-inflation policies would be zero, since the tests performed do not permit us to rule out the role of inertia in these countries.

In sum, due to the presence of inertia, policy makers may have to accept a short-term output loss as the price to pay to gain control of the inflation rate. Such inertia, and hence output loss, may be reduced by establishing the credibility of an anti-inflation program. Since a sudden disinflation could cause a big recession, even if the disinflation is expected, a gradual and expected monetary deceleration may be less disruptive for real growth and may hence be more appropriate. However, a gradual anti-inflation policy could raise serious credibility problems, especially in its early phase. Clearly, economic theory does not provide

explicit or unambiguous guidance concerning the choice between gradualism and drastic shock treatments. Nevertheless, the preannouncment of a feasible path for policy instruments is essential for establishing credibility and reducing inertia.

Finally, several caveats should be borne in mind when interpreting the results in this paper. First, poor specification of anticipated and unanticipated nominal GNP growth is always a danger in this line of research. Second, the tests of the hypotheses were conditional on the maintained hypothesis that nominal GNP growth is exogenous. Third, the model did not test for the effect of a credible change in the policy regime and instead assumed a fixed regime. Fourth, a two-step, single-equation estimation procedure was used rather than a simultaneous equation procedure that takes into account cross equation restrictions. And fifth, the ubiquitous use of significance tests in this paper leaves it susceptible to the criticism, eloquently expressed by McCloskey (1985), that statistical tests of significance, based on theories for random, probabilistic small samples, do not tell the economist whether a fitted coefficient is large or small or equal to unity in an economically significant sense. Therefore, the empirical conclusions of this paper should be regarded as being tenative, provisional and subject to these caveats.

APPENDIX

The International Financial Statistics (IFS) served as the source of annual data for this study. For each country the estimation was carried out using the longest data spans available for that country. The individual time series used are described below. Except for exports, the price data described in paragaph (ii) was used to obtain real values of variables.

(i) Nominal GNP. IFS line number 99a was used for all 13 countries.

(ii) Prices. The GDP deflator, IFS line number 99 bip, was used for Colombia, Greece, Israel, Korea, Mexico, and Thailand. The GNP deflator, IFS line number 99 aip, was used for the Philippines and Turkey. For the remaining countries--Brazil, India, Malaysia, Peru, and Portugal--the consumer price index, IFS line number 64, was utilized.

(iii) Import prices. IFS line number 75 was used for Greece, India, Israel, Malaysia, the Philippines, and Thailand; IFS line number 76x was used for Colombia, Korea, and Portugal. Since a time series for import prices was not available for Brazil, Mexico, Peru, and Turkey, industrial country prices (IFS line number 110.64x) were used as a proxy for import prices. The domestic currency exchange rate with the SDR, IFS line rb, was used to convert this index into domestic currency units.

(iv) Money Supply. IFS line numbers 34 and 341 were utilized for narrow money and broad money, respectively.

(v) Government Expenditure. Consistent time series for government expenditures were not available for Colombia, Mexico, Portugal and Turkey. For the remaining 9 countries, IFS line number 82 was used.

(vi) Capital Formation. Gross fixed capital formation (IFS line number 93e) was used in all countries except Israel and Malaysia, where IFS line number 93 (gross capital formation) was used.

(vii) Fiscal Balance. Consistent time series for the fiscal balance were not available for Mexico, Portugal and Turkey. IFS line number 80 was used for the remaining countries.

(viii) Exports. Adequate data was not available for Colombia. IFS line number 70 was utiized for the remaining countries. Export data was deflated by the unit value of exports index (IFS line number 74) to obtain real exports, except for Mexico and Portugal where adequate export price data was not available.

(ix) Exchange Rates. IFS line rf, the period average of the market rate of local currency per U.S. dollar was used for all countries.

(x) Current Account Balance. Except for Portugal for which a consistent time series was not available, IFS line number 77azd was multiplied by the exchange rate to obtain a series denominated in local currencies rather than U.S. dollars.

(xi) Terms of Trade. The necessary data was not available for Mexico, Peru and Portugal. For the remaining countries, the ratio of the unit value of exports (IFS line number 74) to the unit value of imports (IFS line number 75) was used. The exception was Colombia, where IFS line numbers 76 and 76x were used.

(xii) World Money. IFS line number 001.34x was used.

(xiii) Real Income in Industrial Countries. IFS line number 110.99bpx was used.

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