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IMF *Staff Papers*
Vol. 42, No. 1 (March 1995)

The Political Economy of Budget Deficits

ALBERTO ALESINA and ROBERTO PEROTTI*

This paper provides a critical survey of the literature on politico-institutional determinants of the government budget. We organize our discussion around two questions: Why did certain OECD countries, but not others, accumulate large public debts? Why did these fiscal imbalances appear in the last twenty years rather than sooner? We begin by discussing the "tax smoothing" model and conclude that this approach alone cannot provide complete answers to these questions. We then proceed to a discussion of political economy models, which we organize into six groups: (1) models based upon opportunistic policy makers and naive voters with "fiscal illusion"; (2) models of intergenerational redistributions; (3) models of debt as a strategic variable, linking the current government with the next one; (4) models of coalition governments; (5) models of geographically dispersed interests; and (6) models emphasizing the effects of budgetary institutions. We conclude by briefly discussing policy implications. [JEL H6]

SEVERAL, BUT not all, OECD economies have accumulated large government debts in the last 20 years. Why did this happen? Why have certain countries, but not others, experienced large budget deficits for several years? What explains these large cross-country differences?

Figures 1 and 2 highlight the dimension of this problem. Figure 1 shows the debt-to-GNP ratios in seven countries where this measure sharply

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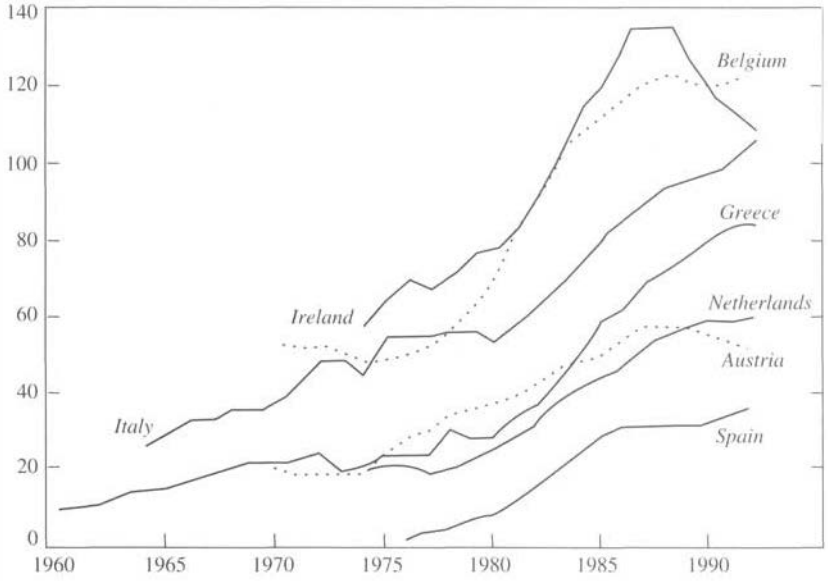
Figure 1. *Rising Debt-to-GNP Ratios*

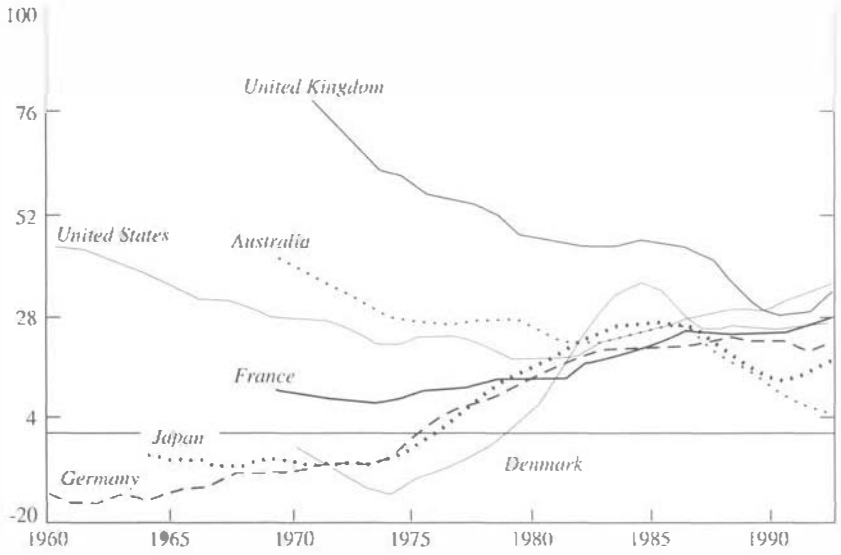


Source: Barro and Grilli (1994).

increased in the last twenty years. In three of these countries (Belgium, Ireland, and Italy) this ratio is more than 100 percent. Figure 2, in contrast, shows the debt-to-GNP ratio in seven countries where this measure appears relatively stable compared with the countries of Figure 1. The difference between the debt-to-GNP ratios among OECD countries in the 1990s is very large—for instance, from more than 100 percent in Belgium and Italy to less than 30 percent in Australia and Germany. The United States is included in Figure 2, but even in this country the increase in the debt-to-GNP ratio in the 1980s and beyond has caused much concern. (See Figure 3.)

It is difficult to explain these large cross-country differences using economic arguments alone: the countries are all advanced industrial democracies, all are members of the OECD, and all have very high levels of per capita income. We believe, instead, that politico-institutional factors are crucial to understanding budget deficits in particular, and fiscal policy in general. While the economies of the OECD countries are relatively similar, their institutions (such as electoral laws, party struc-

Figure 2. *Stable Debt-to-GNP Ratios*



Source: Barro and Grilli (1994).

ture, budget laws, central bank laws, degree of decentralization, political stability, and social polarization) are quite different.

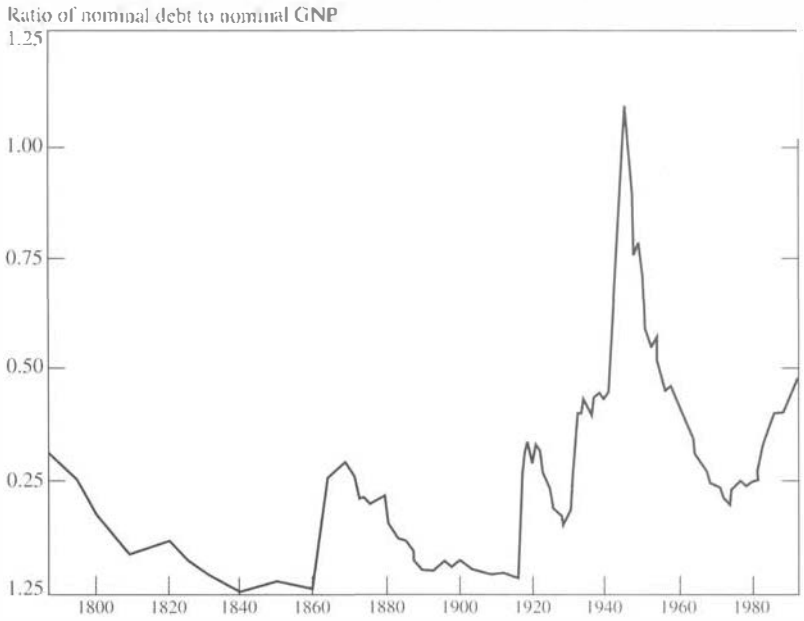
The purpose of this paper is to discuss how the political economy literature can answer two crucial questions:

1. Why do we observe large and persistent deficits in peacetime, and why now?
2. Why do we observe large debts in certain countries and not in others?

An explanation that can answer the first, but not the second, question is not convincing. For instance, a theory that implies that democracies are *always* in fiscal deficit is incomplete if it does not explain why *certain* democracies, but not others, have experienced fiscal imbalances.

The literature on the political economy of fiscal policy is very large and dates back to the nineteenth century with the Italian school of public finance. (See Buchanan (1960)). We do not attempt to cover all of this literature systematically; rather, we focus on the two questions highlighted above and we emphasize recent research.

Figure 3. *Behavior of the U.S. Public Debt, 1790–1991*



Source: Barro and Grilli (1994).

We begin our discussion with a review of the "tax smoothing" theory of the government budget (Barro (1979); Lucas and Stokey (1983)). This approach serves as a normative benchmark from which political economy models depart; in fact, most of the recent political models are "positive" explanations of observed deviations from tax smoothing. Furthermore, the proponents of this theory (for instance, Barro (1986 and 1987)) views it not only as "normative," but also as "positive," that is, as a description of actual fiscal policy.

We will then proceed to a discussion of political economy models, which we organize in six groups: (1) models based upon opportunistic policymakers and naive voters with "fiscal illusion"; (2) models of intergenerational redistributions; (3) models of debt as a strategic variable, linking the current government with the next one; (4) models of distributional conflicts within social groups and/or political parties; (5) models of geographically dispersed interests; and (6) models emphasizing the effects of budgetary institutions. After this critical review, we briefly discuss the policy implications of this research.

I. Optimal Budget Policy

The tax smoothing theory of the government budget considers a closed economy without capital in which a representative agent consumes, works, and saves. The government is a "benevolent social planner" that maximizes the utility of the representative agent. Both the representative agent and the government have the same time horizon, which, for simplicity, is infinite. The theory abstracts from intergenerational aspects and from finite terms of office for governments.

The government needs to finance a certain amount of spending in every period by means of taxes on labor income, which are distortionary since they affect labor supply. The representative agent's utility function depends upon private consumption and leisure; but not on the amount of public good, which we can, for simplicity, define as defense spending.[1] The aim (Barro (1979)) is for the social planner to keep the tax rate constant. The level of taxes is determined by the intertemporal budget constraint, which implies that the present value of spending (which is exogenously given) has to be equal to the present value of taxes. Therefore, budget deficits and surpluses are used as a buffer; deficits occur when spending is temporarily high, and surpluses, when it is low.

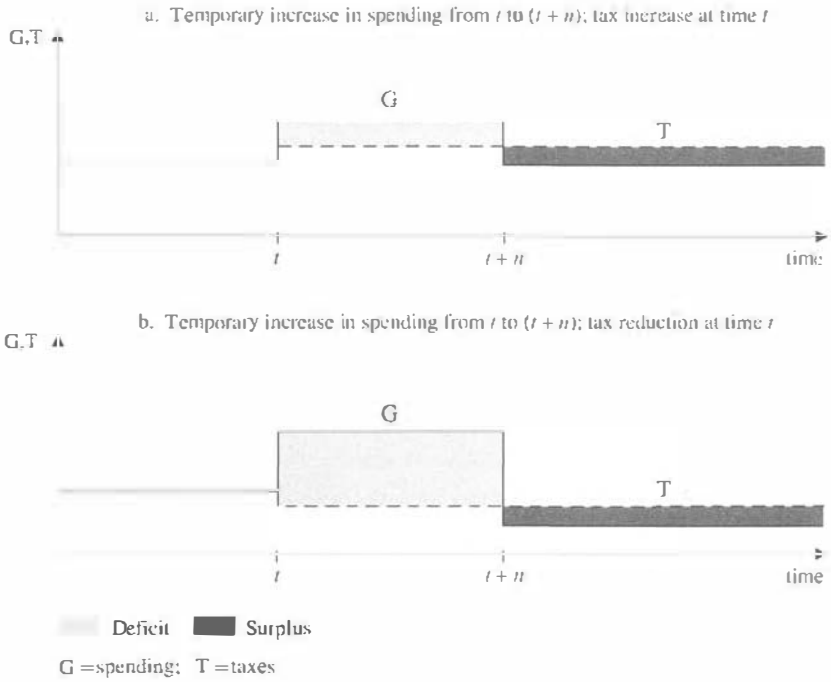
These results directly follow from the concavity of the individual utility function. Suppose that government spending has to be "high" today and "low" tomorrow. A balanced budget policy implies high tax rates today and low tax rates tomorrow. The tax smoothing policy, instead, prescribes constant tax rates, a deficit today, and a surplus tomorrow, which (in present value terms) compensates for today's deficit. The second policy dominates because the additional tax distortions today more than compensate (in utility terms) for the welfare gains of the lower tax rates of tomorrow, due to decreasing marginal utilities. This simple principle has far-reaching implications for fiscal policy, which a few examples highlight.

Example 1: If government spending is constant throughout the planning horizon, the optimal policy prescribes a balanced budget every period.

Example 2: Suppose that from time 0 to time t government spending is constant, and is expected to be constant forever. At time t an unexpected "war" occurs, which it is known will last until $(t + n)$. The optimal policy implies a balanced budget until time t, a "small" permanent tax

[1]The case in which the public goods enters in the utility function of the representative agent introduces some complications that are immaterial for our purposes.

Figure 4. *Tax Smoothing Policy*



increase at t, a deficit between t and $(t + n)$, and a surplus afterward. Figure 4a illustrates the implications of this policy.

Example 3: Suppose that at time t government spending unexpectedly increases temporarily, and then at $(t + n)$ falls permanently below the original level, so that in present value terms we have a reduction of the total amount of spending. (That is, the permanent reduction after $(t + n)$ more than compensates for the temporary increase.) The optimal policy implies a *reduction* of taxes at time t, a deficit between t and $(t + n)$, and a surplus after $(t + n)$. Figure 4b illustrates this example.

The principle of tax smoothing is quite clear: budget deficits and surpluses are used optimally to minimize the distortionary effects of taxation, given a certain path of spending.[2] An important extension of this principle concerns the cyclical fluctuations of tax revenues due to the

[2] The theory becomes formally more complex if government spending is stochastic, but the basic principles of tax smoothing generalize (Lucas and Stokey (1983)).

business cycle. For essentially the same reasons discussed above, the principle of tax smoothing implies that tax rates should be approximately constant over the business cycle; therefore, one should observe deficits during recessions compensated by surpluses in expansions. Therefore, the case of example 1 extended to a model with cyclical fluctuations of output implies a *cyclically adjusted*, balanced budget rule: the budget should be balanced over the business cycle, but not every fiscal year. In this model, there is no role for a Keynesian stabilization policy, since output is not demand determined. In a model with stabilization policies, cyclical fluctuations of the budget should be even more pronounced. In summary, the punch line is that budget deficits should be observed during "wars" and recessions.

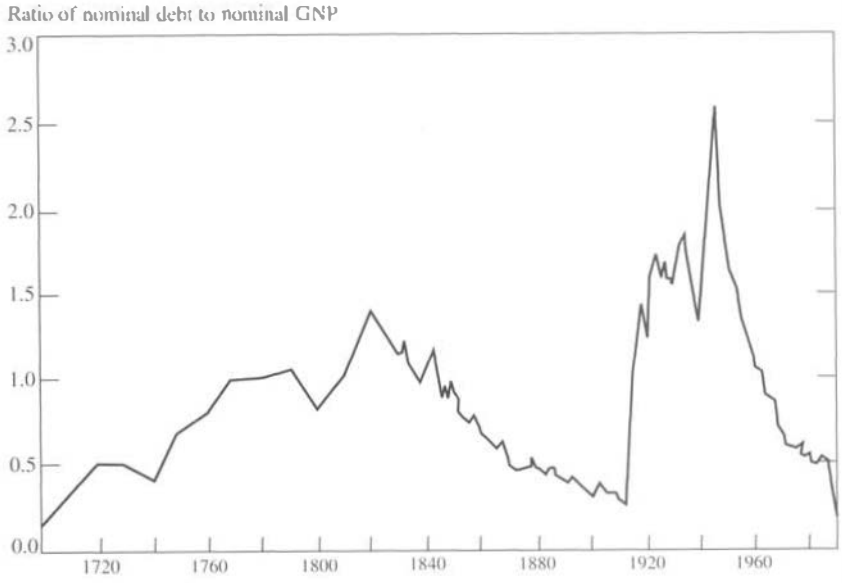
As a normative theory, the tax smoothing model is extremely valuable. Indeed, any positive model of fiscal policy begins with tax smoothing as a benchmark. However, as a positive theory of budget deficits, it is deficient in that it does not answer our two questions. Barro (1986 and 1987) tested the tax smoothing model on 200 years of American and British data. Figures 3 and 5 show that Barro's exercise was quite successful. Both the American and British experiences are generally consistent with the basic principles of tax smoothing: the debt-to-GNP ratios increase during wars, decrease in peacetime, and fluctuate with the business cycle. However, one can identify periods in which fiscal policy appears inconsistent with this theory. For example, the sharp increase in the debt-to-GNP ratio in the 1980s in the United States is, at least at first sight, inconsistent with the tax smoothing model.

To be sure, the tax smoothing theory could explain even this decade (Barro (1991)). Suppose that in the early 1980s it became known that, with a temporary increase in military spending, the cold war could have been won and, by the 1990s, military spending could be cut *below* the initial level in 1980. This is essentially example 3 as described above. The optimal policy in this case is to cut taxes and increase military spending in 1980, run deficits in the 1980s, and run surpluses in the 1990s.

This explanation is not entirely convincing because it relies too heavily on specific assumptions about expectations held in 1980. In some sense, *any* fiscal policy can be rationalized from a tax smoothing perspective, if expectations are a free variable. More generally, this model does not provide totally convincing answers to our two questions on OECD economies.

First, why now? The tax smoothing model can certainly explain why debt-to-GNP ratios started to increase as a result of the 1973–74 recession. One can also argue that policymakers underestimated the need for a fiscal adjustment, since the rates of growth in the decade that

Figure 5. *Behavior of the U.K. Public Debt*



Source: Barro and Grilli (1994).

followed (1974–1984) were generally lower than in the previous decade. However, it is hard to imagine that these miscalculations alone can explain the skyrocketing debt-to-GNP ratios observed, for instance, in Belgium, Ireland, and Italy.

Second, the tax smoothing theory has very little to say in response to the second question: why did the debt-to-GNP ratios increase in certain countries, but not in others? Certainly, different countries may have been hit differently by different shocks and their expectations of future spending might have been different, but we find it quite difficult to explain the variance in the data displayed by Figures 1 and 2 with shocks and predictability of revenues and expenditures.

Therefore, we will now move to politico-institutional approaches.

II. Fiscal Illusion

The "public choice" school, which flourished with the work of Buchanan, Tullok, and associates, has the discussion of excessive deficits in modern democracies as one of its central themes. It goes beyond the

scope (and the space constraints) of the present paper to provide a detailed analytical survey of this literature. Instead, we focus on two crucial ideas that underlie much of the work of this school: fiscal illusion and asymmetric stabilization policies.

In a nutshell, the idea of fiscal illusion is that the voters do not understand the intertemporal budget constraint of the government. When offered a deficit-financed expenditure program, they overestimate the benefits of current expenditures and underestimate the future tax burden. Opportunistic politicians who want to be reelected take advantage of this confusion by raising spending more than taxes in order to please the "fiscally illuded" voters. One of the most forceful discussions of the concept of fiscal illusion is in Buchanan and Wagner (1977).[3]

According to this school, Keynesianism has also contributed to excessive deficits and the abandonment of the responsible budget balance rule. Keynesian stabilization policies become asymmetric: politicians are always willing to run deficits in recessions, but never willing to run surpluses when recessions are over. The fiscally illuded voters do not punish this behavior.[4]

These explanations of budget deficits are not totally convincing for several theoretical and empirical reasons. First, they rely crucially on the notion of fiscal illusion, a notion that goes well beyond the reasonable idea that it is difficult for the electorate to understand the complexity of the government budget. There is a crucial difference between errors and illusions. If voters make uncorrelated errors, on average they do not overestimate or underestimate the costs and benefits of taxes and spending. An illusion implies a systematic bias in these errors. While it is uncontroversial that voters make mistakes and are imperfectly informed, it is not at all obvious why the mistakes should be biased in a certain direction, that is, underestimation of the tax burden relative to the benefits of spending. Second, this theory does not adequately answer the question of "why now?" The deficit problem in the countries of Figure 1 appeared after the early 1970s and in the United States, in the early 1980s. So, why does "fiscal illusion" create problems starting in the 1970s but not before?[5] Third, how do we explain cross-country differences? Are voters more illuded in certain countries than in others? Are politicians more opportunistic in certain countries than in others?

[3] For an early treatment of fiscal illusion see Puviani (1903). See also Wagner (1976).

[4] See Buchanan and Wagner (1977), and several chapters in Buchanan, Rowley, and Tollison (1986).

[5] Note also that Keynesian stabilization policies were more in vogue in the 1960s than in the 1980s.

Buchanan and Wagner (1977) suggest that different tax structures and fiscal institutions may lead to more or less fiscal illusion. For instance, a more complicated tax structure may send noisier signals to the taxpayers concerning the true level of the tax burden.[6] However, we are not aware of comparative studies of OECD tax structures that establish a link between the size of public debt and the amount of fiscal illusion created by different institutions.

An argument somewhat related to the fiscal illusion approach is put forward in the political business cycle literature. The idea is that in election years politicians follow expansionary policies. The voters reward the politicians without understanding (or learning from the past) that pre-electoral expansionary policies will have to be paid for by post-electoral recessions. The literature is large and deserves separate treatment.[7] The point that concerns us is that political business cycles models are not well equipped to explain long-run trends in the debt-to-GNP ratios, while they can explain short-term fluctuations of spending and taxes around elections. For instance, Alesina, Cohen, and Roubini (1992 and 1993) find budget electoral cycles in a sample of OECD democracies. However, their magnitude is small and cannot explain the pattern of debt-GNP ratios shown in Figure 1.

We now turn to several different types of models that do not rely on fiscal illusion and, instead, are based upon rational behavior and expectations. We begin with intergenerational models.

III. Intergenerational Redistributions

The intertemporal nature of fiscal decisions creates links across generations. If each generation cares enough about its offspring, the finite horizon of each generation is immaterial. In particular, the Ricardian equivalence result (Barro (1974)) implies that, given enough intergenerational altruism, the choice of how to finance a given level of spending is irrelevant.[8] In particular, the distribution of tax burden across generations is not influenced by the size of the debt: changes in public debt are compensated by changes in private bequests.

In models where the Ricardian equivalence does not hold, public debt may instead generate intergenerational redistributions if the generation that is alive today leaves the burden of the debt to future generations.

[6] Actually, it is not a priori obvious why a noisier signal implies a systematic downward bias in the perception of the true tax burden.

[7] For a recent survey of this literature see Alesina (1993).

[8] Taxes are nondistortionary in this model.

Since only the current generation votes, in principle, a selfish generation could vote for policies that shift the burden of taxation to the future. However, this behavior is limited by intergenerational altruism: parents do care about their children.

Cukierman and Meltzer (1989) propose an interesting political model of intergenerational redistributions. Suppose that in the current generation we have "rich" and "poor" parents. The former are individuals who plan to leave positive bequests to their offspring and for whom Ricardian equivalence holds: they are indifferent to the debt policy since they can compensate any change in current taxes and deficits with adjustments in their bequests.[9] The "poor" are individuals who would like to leave negative bequests. Since, however, negative bequests are not permitted, the poor would like to run government deficits; as a result, they indirectly borrow from future generations. Therefore, one group of agents (the rich) is indifferent to any debt policy, the other group (the poor) favors public debt. As a result, the social choice is likely to lead to debt.[10]

The idea that public debt redistributes in favor of the current generation of voters, while future voters have no voice, is quite powerful. However, it is not sufficient to provide a complete answer to our two questions. First, why now? Why have these intergenerational redistributions through the government budget increased so sharply over the last twenty years and not before? Note that if growth is increasing, then it might make sense for the current generation to shift the tax burden to the next one. However, growth has, if anything, been decreasing in OECD countries in the last twenty years relative to the previous two decades. Second, why in certain countries and not in others? Is intergenerational altruism stronger in certain countries than in others? High public debts have often been accumulated and sharply reduced within the lifetime of one generation (Alesina (1988)). Why should future generations (i.e., the children of today) honor public debt obligations rather than default? This point is particularly relevant for Cukierman and Meltzer (1989), who assume that private negative bequests are not enforceable, while the public negative bequest (i.e., public debt) is enforceable, that is, the public debt cannot be defaulted.

Tabellini (1991) answers this last criticism by arguing that *inter*generational redistributions interplay with *intra*generational redistributions. A choice of default redistributes from debt holders to taxpayers, that is,

[9] Taxes are lump-sum in this model.

[10] Although Cukierman and Meltzer (1989) emphasize a social choice reached by majority rule, even a benevolent social planner would choose to issue debt. In fact, one group of agents is indifferent to debt, while the other benefits from it, since it removes the non-negativity constraint on private bequests.

from the old to the young and from the rich, who hold the debt, to the poor, who do not. A rich young taxpayer may dislike default even though he does not hold any debt because he cares about the welfare of his old and rich father. Thus, the antidefault coalition includes some of the young people who do not hold debt, because of intergenerational altruism. Tabellini (1991) shows that, under certain conditions, the political equilibrium implies issuing debt, which is then honored.

The interesting contribution of Tabellini's paper is its emphasis on intragenerational distribution. In fact, we shall argue below that the answers to our two questions have more to do with *intra*generational conflicts over distribution rather than with *inter*generational conflicts. However, even Tabellini's paper cannot answer the two crucial questions: why now and why only in certain countries? In the next two sections we move to models that consider conflicts within the same generation.

IV. Debt as a Commitment: The Strategic Role of Debt

The stock of debt links past policies to future policies. The current policymaker can affect the state of the world inherited by his successors through his fiscal choices, which determine the size of the debt.

Alesina and Tabellini (1990) argue that a government can take advantage of this strategic possibility and show that this political game between governments in office at different points in time can lead to an accumulation of government debt beyond the optimal level prescribed by the tax smoothing model. The simplest illustration of this idea is as follows: consider a two-party system in which the two parties have different preferences over the composition of public spending. For concreteness, let us say that one party likes "defense," while the other likes "social welfare." The two parties are ideological, that is, they represent the interests of different constituencies.[11] Suppose that the party that likes defense is in office today, and the result of the next election is uncertain. This party spends on defense and issues debt so that if the social welfare party is in office tomorrow, it will have to service the debt and will not be able to spend much on welfare. By committing future tax revenues to debt service, today's government can reduce spending of future governments. This strategic interaction leads to deficits even though a social planner who maximizes the weighted average of utilities of the two groups would choose to balance the budget in every period. The amount

[11] See Wittman (1983), Calvert (1985), Alesina (1988), and Alesina and Rosenthal (1995) for discussions of voting models with ideological parties.

of borrowing of today's government is larger the more *polarized* are the two groups' preferences on the composition of government spending and the more unlikely it is that today's government will be reappointed tomorrow.

Persson and Svensson (1989) provide a related model in which the two parties disagree, not about the composition of government spending but about its level: they consider a high spender and a low spender. An important difference between the two models is that while Alesina and Tabellini (1990) predict that both parties will issue debt, Persson and Svensson do not: only the low spender does. The intuition is that by lowering taxes and issuing debt, the low spender constrains future spending. On the other hand, by creating surpluses the high spender encourages future spending.[12] The model by Persson and Svensson is symmetric: one party creates deficits, the other one surpluses.

Tabellini and Alesina (1990) develop a more precise relationship between deficits and polarization of *individual* preferences, rather than *party* preferences. They consider a model where decisions are taken by majority rule, and any proposal can be made and voted upon in pairwise comparisons. Under these conditions, the "median voter theorem" implies that the policy adopted is the one most preferred by the median voter.[13] With uncertainty about the preferences of future majorities over the composition of spending, the current median voter prefers to issue debt to tilt the future composition of spending in his favor. Tabellini and Alesina show that the amount of debt issued is increasing in the dispersion of voters' preferences: the more concentrated toward the extreme are the electorate's preferences, the larger is the debt.

This class of models suffers from the same problem we pointed out in models of intergenerational redistributions: public debt does not commit future governments if the latter can default. Alesina and Tabellini (1989) address this problem in a model of an open economy where the costs of default are modeled (quite roughly) as an output loss. The costs of default imply a constraint on the current government's ability to issue debt: at most, today's government can issue an amount of debt that makes the next government indifferent between defaulting and servicing the debt. This principle is quite general and should not depend on the specific assumptions concerning the costs of default.

[12] Persson and Svensson's results differ according to how "extreme" the two parties are in their preferences.

[13] This model is equivalent to one in which two parties compete for office and only care about winning. Both parties converge to the policy preferred by the "median voter"; this is the "median voter theorem" (Black (1963) and Downs (1957)).

In all the models reviewed thus far in this section, the strategic role of debts consists of creating constraints for future governments, but the level of debt does not directly influence the electoral result. Aghion and Bolton (1990), Milesi-Ferretti (1995), and Milesi-Ferretti and Spolaore (1994) argue that incumbent governments can use strategically public debt to influence the election outcome, by influencing the preferences of the electorate. For example, suppose that the party of the left is expected to be more prone to default, since the upper class holds the largest fraction of the public debt. Aghion and Bolton show that right-wing governments would choose to issue debt in order to make a larger fraction of the population debt holders. As a result, the left, which favors default, loses support. Milesi-Ferretti shows that the composition of debt between nominal and indexed can be used strategically along the same lines, if the left-wing party is more inflationary than the right wing one. Milesi-Ferretti and Spolaore (1991 and 1994) investigate in this context the general problem of "strategic inefficiencies," namely, when it is in the interest of a rational incumbent to create inefficiencies on purpose and by doing so increase the probability of reelection.

How do these strategic models face the facts? Let us begin with the question "why now?" As we have seen, Alesina and Tabellini (1989 and 1990) and Tabellini and Alesina (1990) argue that political polarization and frequent government changes should be associated with larger debts.[14] The 1970s and 1980s have witnessed much more frequent changes of governments from left to right and vice versa than the previous two decades. In the period 1960 to 1972 (up to the first oil shock), one observes in the OECD economies a significant government change on average about once every 10.5 years; from 1973 to 1987 about every 6.5 years.[15] Thus, governments have been less certain of their reappointment in the post-1972 period than in the previous decades. The OECD economies have also become much less stable in the post-1973 period: political and economic instability are likely to be strictly interconnected and feed upon each other (Alesina and others (1992) and Alesina and Perotti (1995)).

Why do public debts accumulate in certain countries and not in others? Theory implies that high-debt countries should have more polarized

[14] The frequency of government changes can be taken as a very rough indicator of uncertainty.

[15] A government change is defined as significant when it involves a change in the party in office or a substantial change in the coalition. Data are from Alesina, Cohen, and Roubini (1992), who also provide more precise definitions and the list of 18 OECD economies included in the sample used for these calculations.

political parties and a more polarized electorate, with strong extremist groups. Alesina (1989) constructs a very rough index of political stability for OECD countries for the 1970s and 1980s based on several politico-institutional characteristics.[16] The index increases in instability over the period. The average value for the countries in Figure 1 is 3.3; the average value for countries in Figure 2 is −0.1. This difference is large, since the highest value of the index for the countries included in the two figures is 6 and the lowest is −3.0.[17]

The models reviewed in this section have also been used to explain several specific episodes of debt accumulation. For instance, Alesina and Tabellini (1990) interpret the U.S. deficits during the Reagan administration as a maneuver to constrain future Democratic administrations' spending on social welfare.[18] It is quite certain that President Clinton's budget would have been more generous on domestic spending if he had faced a lower interest bill. Persson and Svensson (1989) have argued that their model explains the deficits of the Reagan years and the Swedish deficits resulting from the conservative government of 1976–82. Aghion and Bolton's (1990) model also explains episodes of deficits under conservative governments.

In summary, the class of models reviewed in this section suggests a relationship between the nature of party competition, polarization of preferences, and electoral uncertainty. These are variables that can be measured and that do vary across countries and time periods. Therefore, these models are testable and, in principle, can provide answers to the questions "why now?" and "why in certain countries?" However, the empirical work based upon these models has thus far been sketchy and, at best, suggestive.

V. Distributional Conflicts and Wars of Attrition

The models discussed in the previous section emphasize a strategic interaction between political parties in office at different points in time.

[16] These are: whether or not the country has experienced one transition from dictatorship to democracy; whether one finds significant extreme right-wing parties and communist parties in the country; a measure of frequency of government changes; whether or not the country has linguistic or regional conflicts; whether elections can be called by the executive, or their timing is fixed by the constitution; and the average size of coalitions.

[17] Ireland is not included in these calculations because the instability index is not available for this country.

[18] An op-ed article of the *New York Times* on January 25, 1987, stated that "This deficit is no despised orphan. It is President Reagan's child, and secretly, he loves it, as David Stockman has explained: The deficit rigorously discourages any idea of spending another dime for social welfare."

In this section we review models in which deficits are the results of strategic conflicts between political parties or social groups that have an influence on policy decisions *at the same time*. For instance, while previously we focused on the conflict and the ideological polarization between parties that alternate in single-party governments, here we are concerned with the polarization of parties that are members of the same coalition government.

Alesina and Drazen (1991) propose a war of attrition model of delayed fiscal adjustments in which different sociopolitical groups fight about the distribution of the fiscal burden. The model assumes that a permanent shock perturbs the government budget, so that at the existing tax rates, a deficit appears and the debt begins to accumulate. A social planner would react immediately to this shock and raise tax revenues in order to keep a balanced budget.[19] The point of the model is that the distributional struggle among social groups delays the adoption of the efficient policy of balancing the budget. More specifically, when the deficit appears, it is financed partly by external debt accumulation[20] and partly by some form of highly distortionary taxation, for instance, seigniorage. A stabilization is defined as a change of policy that stabilizes the debt-to-GNP ratio and substitutes the prestabilization taxation with a less distortionary "regular" form of taxation.

Suppose that two groups have to decide on how to share the fiscal burden of the stabilization.[21] The longer they wait, the higher are the costs. The prestabilization fiscal distortions persist over time; the debt accumulates, so that higher taxes are needed to service it after the stabilization. An immediate agreement on how to share the fiscal burden of stabilization makes both groups better off relative to the same agreement reached with delay. However, rational delays occur under two conditions: if the proposed stabilization is "inequitable," namely, one group has to bear a disproportionate share of the fiscal burden; and if neither group knows how costly it is for the other to postpone the stabilization.[22]

These costs can be interpreted in two non-mutually exclusive ways: one emphasizes the economic costs of the prestabilization distortions, and the

[19] For simplicity and clarity of exposition, this model implies that the optimal tax smoothing policy implies a permanently balanced budget.

[20] With some modification in the notation and in the model construction, the analysis can be applied to the case of domestic debt.

[21] With some complications, the model can be extended to more than two groups.

[22] The original model of war of attrition in a biological context was formalized by Riley (1980). Bliss and Nalebuff (1984) further developed it. Kennan and Wilson (1988) apply this model to labor strikes.

other emphasizes the political costs (lobbying, political action) of preventing the other group from imposing an undesirable fiscal plan.

The "loser" is the group that pays the larger share of the fiscal stabilization; the "winner" is the other one. Generally, neither group will accept being the "loser" immediately: each hopes that the other will concede first. The optimal concession time is determined by equating the marginal cost of waiting with the marginal benefit of waiting. The marginal cost is the utility cost of living another instant in the unstable and distorted economy. The marginal benefit is given by the conditional probability that the other group will concede in the next instant multiplied by the difference in utility between being the "winner" and being the "loser," that is, between paying the lower or the higher share of the fiscal burden.

The more unequal is the distribution of the stabilization costs, the later is the expected time of stabilization. The intuition is clear: the more unequal is the burden of stabilization, ceteris paribus, the higher are the benefits from waiting. Furthermore, the lower the costs of living in an unstable economy are, ceteris paribus, the later stabilization occurs. This suggests that economic mechanisms, such as indexation clauses, which reduce the cost of macroeconomic instability, tend to postpone adjustments; and political mechanisms, which make it easier and less costly to exercise a veto power and "block" proposed stabilization plans, also delay stabilization.

Drazen and Grilli (1993) extend this model by showing that an economic crisis may anticipate the stabilization by forcing a solution to the war of attrition. An increase in the prestabilization costs due to a crisis makes it so costly to continue the war of attrition that one group concedes. Thus, an economic crisis can, in the end, be socially beneficial: while it has its costs, it shortens the delay in the adoption of the necessary stabilization.[23]

Spolaore (1993) applies war of attrition models to coalition governments. He considers fiscal shocks that create budget deficits. Given these shocks, a social planner would follow the optimal policy, which is modeled as a function of the costs of adjustment and the persistence of the shock. Spolaore takes this optimal policy as a benchmark and shows that a coalition government delays adjustment, while a single-party government reacts too much relative to what a social planner would do. This result arises because different parties represent the interests of different constituencies, each of which would like to be spared from

[23] Drazen and Grilli (1993) note that Hirschman (1985) made a similar argument informally.

taxes. A coalition government delays the fiscal adjustment until the veto power game among coalition members is resolved;[24] as a result, a coalition government does not adjust as often or as much as a social planner would do. On the contrary, a single-party government overreacts to the fiscal shock, since it underestimates the social costs of adjustment. In fact, its constituency can be protected so that it does not bear any cost. Spolaore also shows that the inefficiencies in policy reactions in a coalition government increase with the number of coalition members. In summary, Spolaore's research attributes the accumulation of public debt, in part, to the fragmentation of governments and to the degree of political cohesion.

How do these models answer our two questions? First, "why now?" War of attrition models explain why countries delay adjustments to shock, and therefore can explain the procrastination of fiscal adjustments. However, these models do not explain the cause of the original shock that perturbed the fiscal balance. Roubini and Sachs (1989a and 1989b) and Von Hagen (1992) show that until the first oil shock, by and large the OECD economies had followed fiscal policies empirically undistinguishable from the tax smoothing model. After the oil shock, certain countries let their government debt explode by delaying the necessary adjustment. With different models one can explain different responses to a common shock, but not the origin of the shock itself.

Why certain countries and not others? Weak coalition governments have typically postponed fiscal adjustments and have accumulated debt. Roubini and Sachs (1989a and 1989b) construct a political indicator that assumes increasing values as government fragmentation increases. They show that, after controlling for several economic determinants of budget deficits (suggested by the tax smoothing model), their political variable is highly significant: the higher the number of parties in a coalition government, the higher is public debt. Grilli, Masciandaro, and Tabellini (1991) also show that longer-lived governments have smaller deficits. This finding is consistent with the previous one, since coalition governments typically have shorter lives than single-party governments.

The nature of party systems and of government structure depends on the electoral system. For instance, proportional, electoral systems typically create multiparty systems and coalition governments; on the contrary, majoritarian systems typically lead to single-party governments. Furthermore, government durability is lower in representational systems characterized by coalition governments (Grilli, Masciandaro, and

[24] Unlike Alesina and Drazen (1991), Spolaore (1993) relies not on asymmetric information but on randomization to obtain delays.

Tabellini (1991)). Therefore, one can suggest a relationship between the type of electoral system and the level of debt. This observation certainly fits the cases of Belgium, Ireland, and Italy, the three OECD countries with the largest debt-to-GNP ratios.

The American version of coalition government is the relatively common situation of divided government, that is, when the same party does not hold the Presidency, a majority in the House, and a majority in the Senate.[25] A widely held view, both in the popular press and in academia, is that divided government in the 1980s was responsible for the buildup of American deficits.[26] The problem with this argument is that divided government is not a novelty of the 1980s: it occurred often in the past. On the other hand, the 1980s are a rather unique example of peacetime, nonrecessionary buildup of debt. Why didn't divided government create the same deficits in previous decades as in the 1980s?[27]

Poterba (1994) and Alt and Lowry (1994) present evidence on the effect of divided government by looking at American states. They consider the policy response to fiscal shocks and find that the adjustment is slower in states with divided control than in states with unified control. Their results are remarkably similar in spirit to those by Roubini and Sachs (1989a and 1989b) on OECD economies: in both cases coalition or divided governments do not *create* budget deficits, but rather, procrastinate the adjustment to shocks.

In summary, the models surveyed in this section establish links between institutional features, party structure, and budget deficits. The empirical evidence is quite encouraging for these models, perhaps more so than for the somewhat related approach of Section IV. Finally, note that institutions such as electoral systems are themselves endogenous: they do change over time, although infrequently. Thus, the researcher faces a challenging question: to what extent can we take institutions as exogenous in explaining deficit biases?

In the next two sections we look at models that examine legislatures and the details of budget institutions more closely.

[25] For a more extended discussion of similarities and differences between divided government in the United States and coalition governments in Europe, see Alesina and Rosenthal (1995), Chapter 10; Fiorina (1991); and Laver and Shepsle (1991).

[26] See, for instance, McCubbins (1991) and the criticism by Barro (1991).

[27] McCubbins (1991) argues that what matters is not the division between the President of one party and a Congress with a majority of the other party, but division between Senate and House. The latter case, which occurred from 1981 to 1986, is much less common. However, McCubbins's argument still relies largely on one observation.

VI. Geographically Dispersed Interests

A large political science literature has studied how the organization of legislatures leads to inefficient fiscal decisions.[28] Although this research focuses on the U.S. Congress, its implications are broader: for the purpose of our paper, we focus on models in which the geographic base of members of Congress leads to "excessive" spending.

Weingast, Shepsle, and Johnsen (1981) argue that representatives with a geographically based constituency overestimate the benefits of public projects in their districts relative to the financing costs, which are distributed nationwide. The aggregate effect of rational representatives facing these incentives is an oversupply of geographically based public projects. Specifically, the size of the budget is larger with N legislators elected in N districts than with a single legislator elected nationwide, and the budget size is increasing in N, the number of districts. The voters of district i receive benefits equal to B_i for a project, but have to pay $1/N$ of the total costs if taxes are equally distributed among districts. Thus, a geographically based representative does not internalize the effect of his proposals on the tax burden of the nation.

These models typically explain the size of budgets and, in particular, of expenditures on pork barrel projects; therefore, they do not directly address the problem of budget deficits. However, these models can be very useful in answering our questions, if two issues are taken into account. First, the models should be made dynamic, so that they can address not only the *size* of the budget, but also its *balance*. Second, one must keep in mind that the share of OECD country budgets devoted to pork barrel projects is shrinking relative to the share of transfer programs and entitlement. To be sure, some of the transfer programs have geographically based constituencies. For example, Florida has a high concentration of old age pensions, and invalidity pensions have been used as a transfer system from northern to southern Italy (Emerson (1988)). These are cases in which income redistribution and geographical redistribution become highly interconnected. However, strictly defined pork barrel projects are only a relatively small part of current budget problems in OECD economies.

The crucial insight of this literature is, nevertheless, important: the geographical distribution of costs, benefits, and decision power can make an important difference to the aggregate budget. In particular, one can

[28] See, for instance, Ferejohn (1974); Fiorina and Noll (1978); Shepsle and Weingast (1981); Weingast, Shepsle, and Johnsen (1981); and Baron and Ferejohn (1989).

think of an analogy between some issues of fiscal federalism and the model by Weingast, Shepsle, and Johnsen (1981). Suppose that spending decisions are taken at the local level, and are financed with transfers by the national government, which raises taxes. The same mechanism operates in this case as in the case of geographically elected representatives. The local authorities do not fully internalize the effects of their spending decisions over the overall budget for the same reasons that the geographically elected representatives do not. Clearly, the incentives for the local authorities are different if they are responsible for both taxing *and* spending decisions.[29]

The discussion of federalism has recently picked up momentum, both in the United States and Europe.[30] Fiscal arrangements linking the center to local authorities vary greatly across countries. Furthermore, Hughes and Smith (1991) suggest that from 1975 to the late 1980s one can detect an increase in the fiscal responsibilities of local authorities. Whether or not this cross-country and temporal variation of federalist arrangements can explain budget deficits is still an open question,[31] and is an important topic for future research.

VII. Budgetary Institutions

Budgetary institutions are all the rules and regulations according to which budgets are drafted, approved, and implemented. These rules greatly vary across countries; thus they can potentially explain cross-country variations in deficits and debts.

Budget institutions have an effect on fiscal policy outcomes if two conditions hold: if budget institutions are more difficult to change (de jure or de facto) than the budget law itself, and if budget institutions influence the final vote and the implementation of the budget. Both conditions are met in reality, at least up to a point. Budget institutions change rather infrequently, although they *can* be changed when they do not satisfy the needs of a community.[32] The crucial issue, however, is that budget institutions cannot be changed as easily and frequently as the budget itself; if they could, they would be totally ineffective.

[29] Different federalist arrangements can have important implication for fiscal redistributions and fiscal stabilization.

[30] See the recent survey by Hughes and Smith (1991) and the references cited therein.

[31] For a fragment of evidence along this line see the comments by Tabellini on Hughes and Smith (1991).

[32] The Congressional Budget Act of 1974 in the United States is an example of a major reform of budgetary institutions.

Whether or not institutions actually affect the final outcome of a legislative vote (and its implementation) is a major item on the research agenda of modern political science. Shepsle (1979) shows that the structure imposed by certain procedural institutions helps solve the Arrow's impossibility problem in legislatures.[33] For instance, a key issue is who holds the agenda setting power and what types of amendments are admissible in the legislature floor: generally speaking, the theory suggests that procedural rules that limit universalism and reciprocity are conducive to fiscal restraint. "Universalism" is defined as the property of a budget that includes "something for everybody." "Reciprocity" is an agreement not to oppose another representative's proposal in exchange for the same favor. As for the case of the models of the previous section, research in this area has an American focus, and virtually all the formal models are more oriented to explaining the *size* of the budget than the intertemporal allocation of spending and taxation (i.e., the budget balance).[34]

A recent paper by Von Hagen (1992) answers our two questions concerning budget deficits by focusing on the budgetary institutions of the 12 members of the EEC. He tests an interesting structural hypothesis, namely, that budget procedures lead to greater fiscal discipline if they give strong prerogative to the prime minister or the finance minister; limit universalism, reciprocity and parliamentary amendments; and facilitate strict execution of the budget law."

Von Hagen constructs indices that summarize several budgetary institutions. The most comprehensive index used in this study includes classifications of countries as a function of: (1) the strength of the position of the prime minister (or finance minister) in intragovernment negotiations; (2) the limits (or lack thereof) to parliamentary amendments; (3) the type of parliamentary votes (item by item, global, etc.); (4) the timing of parliamentary votes; (5) the degree of transparency of the budget; and (6) the amount of flexibility in the implementation process.

The classification of countries according to these criteria inevitably requires some judgment calls, particularly since the author attempts to capture de facto procedures, beyond the letter of the law. Nevertheless, the strong support that he finds for the structural hypothesis is convincing. In particular, he finds that several related indices of budgetary

[33]For more specific application to the budget process see Ferejohn and Krehbiel (1987), Ferejohn, Fiorina, and McKelvey (1987), Baron and Ferejohn (1989), Baron (1991), and Weingast and Marshall (1988).

[34]For a more comparative approach see Wildavsky (1986) and the reference cited therein.

institutions are significant explanatory variables for cross-country differences in the debt-to-GNP ratios and budget deficits in the 1980s in the EEC; the structural hypothesis receives rather strong support.

Von Hagen's institutional data are quite rich and deserve further exploration. For instance, these aggregate indices incorporate many institutional differences. A comparison between two "fiscally responsible" countries, France and Germany, illustrates the point. France has a very high index[35] owing to its voting rules and the role of the Prime Minister. Germany's voting rules are actually among the least compatible (at least on paper) with fiscal responsibility; however, Germany also has a high index because of budget transparency and inflexibility in the implementation.[36] That is, one finds much variability of institutional arrangements, even within countries with the same aggregate index.[37]

American states are a second example on which one can test the idea that budgetary institutions matter. American states have a variety of different arrangements concerning their budget. In addition to different procedures for budget formation, some states have "hard" balanced budget rules, others have "soft" balanced budget rules, while a few have no such rules. Three recent empirical papers make the point that budget rules do make some difference, although probably not as much as the letter of the law would imply. Von Hagen (1991) concludes that budget rules have some effect on the level and composition of state debts. Alt and Lowry (1994) and Poterba (1994) argue that American states with harder balanced budget rules react more promptly and more energetically to negative revenue shocks or positive spending shocks.

In summary, the crucial message of this research is that budgetary institutions influence fiscal policies. Does this insight help to answer our two questions? Institutional differences can certainly contribute to answer our second question: why in certain countries and not in others? As for the first question (why now?), there might be more of a problem. As Von Hagen (1992) notes, budgetary institutions are relatively stable over time. Thus, how can we explain the sharp increase in the cross-country variance of fiscal performances in the 1970s and 1980s relative to the two previous decades?

[35] The indices are defined as increasing with the structural hypothesis.

[36] In fact, in variations of the basic index in which these two characteristics are not considered, Germany's rank drops a few positions.

[37] Von Hagen (1992) also tests less successfully another hypothesis, focusing on the existence of long-term (i.e., multiyear) budget plans. This hypothesis is harder to test and the proposed indices probably rely too heavily on the existence of long-term budget proposals that are not truly binding. See Tanzi (1994) for a discussion of the perverse effect of noncredible long-term budget plans.

One possible answer is to consider the effect of economic shocks in countries with different budgetary institutions, along the line of war of attrition models. Perhaps the consequences of budgetary institutions not adequate to enforce fiscal responsibility have a particularly negative impact in periods in which fiscal adjustments are needed. In our view, this is a promising avenue to be explored further with careful comparative empirical work.

VIII. Policy Implications

The policy implications of the political economy literature are particularly relevant for institutional reforms. If policy outcomes are influenced by politico-institutional variables, then in order to improve policymaking one has to intervene at the institutional level. Several OECD economies are struggling with fiscal adjustment programs and fiscal reforms. Formerly planned economies are in the process of building new fiscal institutions, and their policy advisors have to deal with institutional questions.[38]

There are two types of institutional reforms: changes in the legislation directly regulating the budget formation, and more general institutional reforms, such as changes in electoral laws.

The Budget Formation

Balanced Budget

One of the most commonly advocated reforms of the budget process is the introduction of a balanced budget law, or more generally, of regulations that limit the discretion of each government in running deficits.[39] The tax smoothing theory implies that, in general, a balanced budget policy is suboptimal. However, we have also argued that this theory is not a completely accurate description of actual fiscal policies. Thus, two questions arise: is a suboptimal balanced budget policy superior or inferior to the suboptimal policy obtained without the balanced budget law, and how can one make a balanced budget law enforceable?

The first question is difficult, since it involves comparisons of second-best outcomes. Generally, the larger are the politically induced inefficiencies, the more attractive is the option of a balanced budget law. For

[38] On this point see Tanzi (1992) and (1993).
[39] For instance, Buchanan and Wagner (1977).

instance, if it is true that proportional electoral systems with coalition governments are more likely to procrastinate budget adjustments, then a balanced budget law is particularly appropriate in these systems.

The costs of a balanced budget law are the loss of fiscal stabilization over the cycle and the loss of flexibility in reacting to shocks on expenditure or revenues. In theory, these problems could be overcome by a contingent rule—for instance, a cyclically adjusted balanced budget rule. However, the more complicated the rule, the harder it is to enforce it.[40]

The enforceability of a balanced budget law is also a complex question. Any law can be changed by a sovereign, even though certain laws are more difficult to change than others. For instance, a constitutional amendment is typically the most difficult law to change, since it requires the most complex procedures and the highest qualified majorities in the legislature. This is why the most enthusiastic supporters of balanced budget rules favor this institutional solution.

The procedural choice runs into the usual trade-off between commitments and flexibility: by making it very difficult to change the law, one makes commitments more credible but reduces the possibility of reacting to unforeseen shocks. When a certain government, representing a certain majority, is in office, it has an incentive to break the balanced budget rule and impose it on future governments. By doing so, the current government achieves the flexibility needed to favor its constituency and leaves the costs of debt *and* the constraint of the balanced budget law on its successor. Thus, if the balanced budget rule can be broken by simple majority and the government commands this majority, then the rule is not credible.

By increasing the size of the majority needed to break the rule, one gains credibility but loses flexibility. A challenging normative problem is to decide what is the optimal qualified majority required to abandon the balanced budget. This majority requirement should be increasing with the politico-economic forces that increase the incentive to run deficits (as discussed in the previous sections), increasing in the predictability of expenditures and revenues, and decreasing the benefits of fiscal stabilizations.

Procedures for Budget Approval

War of attrition models suggest that by limiting the veto power of players involved in the budget formation, one reduces delays in fiscal adjustments and enforces fiscal responsibility.

[40] For a discussion of this point, see Tanzi (1994).

A first-stage war of attrition may be played within the government among spending ministers at the stage of budget formulation; this is most likely to happen in coalition governments where different ministers belong to different parties. Spending ministers are more likely to be sensitive to special interest pressures than the Prime Minister or the Finance Minister; the latter are more sensitive to the overall size and financing of the budget. The effect of intergovernmental wars of attrition is reduced if either the Prime Minister or the Finance Minister has a strong role in the budget formation process. Procedures that make a Prime Minister strong are those that limit the veto power of spending ministers.

A second stage at which wars of attrition may take place and special interests can endanger fiscal responsibility is during the process of legislative approval of the budget. Procedures that limit the type of admissible amendments, and impose *first* a vote on the size of total spending and *then* a discussion of specific items are more likely to limit deficits.[41] By voting first on the overall size of the budget and the balance, one avoids the likely outcome of reconciliating conflicting spending needs with an increase in the deficits.

Central Bank Independence

Several authors have highlighted the superior achievements of independent central banks on the inflation front.[42] Independent central banks may also enforce fiscal responsibility by limiting the government's access to seigniorage as a more or less hidden tax. With an independent central bank, deficits have to be bond financed; this leads to an increase in the debt-to-GNP ratio and, possibly, higher interest rates. In other words, the government faces a harder budget constraint.

Electoral Reforms

Proportional electoral systems lead to coalitions and fiscal deadlocks, which delay stabilizations. Majoritarian systems, by concentrating power in a single party, avoid deadlocks but may create excessive variability of policies, since the party in office is not moderated by coalition partners.[43] As usual in economics, there is a trade-off.

[41]The empirical results of Von Hagen (1992) bring support to these views. For more theoretical discussion, however, see Ferejohn and Krehbiel (1987).

[42]For instance, Alesina and Summers (1993), Cukierman, Webb, and Neyapti (1992), and Grilli, Masciandaro, and Tabellini (1991).

[43]For an interesting formalization of these ideas see Spolaore (1993). For a discussion of policy moderation in coalition government, see Alesina and Rosenthal (1995). See Tabellini and Alesina (1990) for some results on the relationship between the distribution of voter preferences and policy variability.

What position should one take on this trade-off? The literature reviewed here provides partial answers to this question. For instance, countries with a very polarized distribution of preferences (perhaps related to income distribution) may need more proportional electoral systems to avoid extreme policy variability, owing to changes in governments with extreme positions. On the other hand, in periods of economic crisis or transition, coalition governments may be an obstacle to the much-needed swift policy action.

Clearly, electoral laws cannot be changed very frequently; thus countries have to make a relatively permanent choice on this trade-off. Generally speaking, choices toward the extremes of the trade-off are unlikely to be optimal. As for the budget deficits, a mistake toward excessive proportional representation is likely to have more negative consequences than the opposite mistake. This is particularly true if proportional electoral systems are accompanied by budgetary institutions that are not likely to enforce discipline; for instance, a weak Prime Minister in the cabinet or unlimited amendments in the legislature.

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Restraining Yourself: The Implications of Fiscal Rules for Economic Stabilization

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State budgets played a significant macroeconomic role in the United States during the 1970s and 1980s. Their cyclical responsiveness was affected by the severity of statutory and constitutional fiscal restraints. Moving from no fiscal restraints to stringent restraints lowered the fiscal offset to income fluctuations by roughly 40 percent. Simulations indicate that a reduction in aggregate fiscal stabilizers of this size could lead to a significant increase in the variance of aggregate output. [JEL E62, H61, H74]

RESTRAINTS ON the fiscal freedom of budgetary authorities are increasingly in the news. In the United States, the Gramm-Rudman-Hollings Act and associated legislation (discussed in Sheffrin (1987)) limit the freedom of the U.S. Congress to authorize expenditures that are forecast to increase the federal budget deficit. A balanced budget amendment to the U.S. Constitution has been under discussion for some time and was a component of the "Contract with America" on which Republican Party candidates successfully campaigned in the 1994 midterm election. In Europe, the Maastricht Treaty on Economic Union specifies ceilings or "reference values" for the debts and deficits of European

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Union (EU) member states participating in Europe's monetary union (EMU) that could conceivably limit their freedom to adjust their budgets to the cycle.[1]

Most research on statutory and constitutional fiscal restrictions has focused on their effectiveness in limiting debts and deficits. Several investigators have used data for U.S. states, all of which, aside from Vermont, are subject to statutory or constitutional debt and deficit limits. Since the stringency of these provisions differs, the states provide a kind of natural laboratory in which to study the effects of fiscal constraints on behavior.[2] Anderson and ACIR (1987), von Hagen (1992), and Eichengreen (1994) use data for U.S. states to model the determinants of deficits and debts. Bayoumi, Goldstein, and Woglom (1995) and Bayoumi and Eichengreen (1994) use state-level data to examine the connection between fiscal restrictions and the cost of government borrowing.

Political economy analyses emphasizing the tendency for logrolling and pork-barrel politics to bias debts and deficits upward imply that fiscal restrictions designed to bring about their reduction are desirable. This paper suggests that there is, however, another side to this coin. Statutory and constitutional restraints that limit debts and deficits also lower the responsiveness of state budgets to the cycle and hence reduce the extent of the fiscal stabilization. We present evidence of this effect using data on U.S. states. We find that the cyclical component of state budgets, which provide a significant part of overall U.S. fiscal stabilization, tend to diminish with the strength of constitutional and statutory restraints.

In Section I, aggregate data for U.S. state and local governments are used to estimate the extent of automatic stabilization and to test for changes in this role over time. Section II uses evidence disaggregated by

[1] The Maastricht Treaty requires that budget deficits not exceed 3 percent of GDP and that public debts not exceed 60 percent of GDP. These ceilings are subject to qualifications, however. Countries will only be said to be in violation of the deficit rule if the deficit ratio exceeds 3 percent and if in addition either it has not declined "substantially and continuously" to "close to" that level or it cannot be regarded as "exceptional and temporary and ... close to" 3 percent. The debt ratio will be said to be violated only if it exceeds 60 percent and if in addition it is not "sufficiently diminishing and approaching the 60 percent level at a satisfactory pace."

[2] A potential problem is that these restrictions could themselves depend on fiscal behavior. It is possible that stringent statutory or constitutional restraints are imposed in those states with large or widely fluctuating deficits. However, these restraints are generally of sufficient age to be independent of current fiscal conditions. Many states adopted them in the 1840s in response to a prior wave of defaults; by the time of the Civil War, 19 states had adopted some form of constitutional amendment restricting borrowing. As new states were admitted to the union, many incorporated debt limits into their constitutions. See Ratchford (1941) for more details.

government and region to isolate the impact of statutory and constitutional restraints. Section III compares the results for the United States with those for other nations, contrasting countries with both federal and unitary government structures. Section IV uses simulations of a macroeconomic model to assess the implications of fiscal restrictions and the reductions in fiscal stabilization they imply for the volatility of the economy. Section V, in concluding, returns to the implications of the analysis for the debate over the efficacy of a balanced budget amendment in the United States and the fiscal restrictions specified by the Maastricht Treaty on Economic Union.

I. Aggregate Evidence from U.S. States

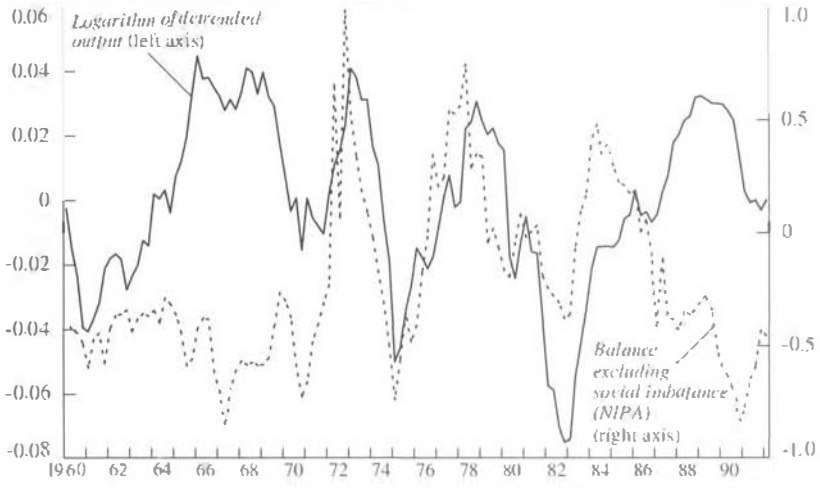
We use quarterly data on budget balances and output since 1960 to analyze the cyclical properties of U.S. state and local government fiscal positions.[3] No attempt is made to distinguish between movements in the fiscal balance due to discretionary policy and those due to automatic stabilizers (nondiscretionary changes in revenues and expenditures caused by changes in output), since it is difficult to make such a distinction for a government sector that operates under fiscal restraints and that may have to enact "discretionary" changes in taxation and expenditure in order to remain within statutory limits. It is also likely that the design of the tax and transfer system, and hence the provision of automatic stabilizers, is affected by these same fiscal restraints; for example, a state with very strict constitutional fiscal controls would be unlikely to adopt a tax and transfer system that was highly sensitive to economic activity.

The association between the aggregate state and local government budget balance and output is displayed in Figure 1, which juxtaposes the balance for state and local governments excluding social insurance payments as a percentage of GDP against the output gap.[4] There appears to be a break around 1970 in the relationship between cyclical movements in output and the fiscal balance. While state and local budget balances displayed relatively little cyclical responsiveness in the 1960s, they followed the cycle more closely in the 1970s and 1980s. By implication, state

[3] The quarterly National Income and Product Accounts (NIPA) aggregate state and local governments. We differentiate between them when we move to annual data below.

[4] The gap is measured as the deviation of the logarithm of output from a quadratic time trend. Social insurance payments are usually excluded since these payments are nondiscretionary and relatively volatile. Including such payments makes no difference to the analysis (Bayoumi (1992)).

Figure 1. *Cyclical Behavior of State and Local Government Fiscal Balances*
(NIPA basis, in percent of GDP)



and local government fiscal balances fluctuated over a relatively narrow range in the 1960s, but their variance increased subsequently.

Behavior in the second half of the 1980s and the 1990s was more complex. The economic expansion from mid-1984 to 1989 was accompanied by a deterioration in fiscal balances, contrary to the presumption of countercyclical fiscal behavior. But in 1990, when output started to fall relative to trend, the deterioration of fiscal balances accelerated, as predicted by the assumption of countercyclical behavior. The balance then started to improve from mid-1991 onward along with the state of the macroeconomy.[5] States appear to have pursued countercyclical policies over the 1991 recession, but not during the preceding expansion.

These relationships can be analyzed more systematically if we assume that the change in the fiscal balance depends upon the rate of growth of real output and on its own lagged value (a term that limits the long-run movement of the balance from its initial equilibrium):

$$\Delta(BAL/GDP)_t = \alpha + \beta\,\Delta\log(Y_t) + \tau(BAL/GDP)_{t-1} + \epsilon_t, \qquad (1)$$

where (BAL/GDP) is the ratio of nominal fiscal surplus to output, Δ is the first difference operator, Y is real GDP, and ϵ_t is an error term.

[5] Bayoumi (1992) provides further discussion of the behavior of state and local government since the mid-1980s.

Table 1. *Cyclical Behavior of State and Local Government Budget Balances*
Estimating Equation: $\Delta(BAL/GDP)_t = \alpha + \beta\,\Delta \ln y_t + \tau(BAL/GDP)_{t-1}$

	1959:2–1969:4		1970:1–1992:1	
	β	R^2	β	R^2
Overall surplus	−.022	.47	.083**	.75
	(.021)		(.022)	
Expenditures	−.080**	.99	−.104**	.96
	(.020)		(.012)	
Revenues	−.104**	.99	−.029*	.85
	(.018)		(.022)	

Notes: The equations were estimated using ordinary least squares. Estimates of the constant term and lagged dependent variable are not reported. One asterisk signifies coefficient is significant at 5 percent level; two asterisks signify coefficient is significant at 1 percent level.

Greek letters represent estimated coefficients. Since the fiscal surplus and real output are both measured as first differences, the coefficient β can be seen as measuring the sensitivity of the level of the fiscal balance to output, with a positive value indicating that the balance varies countercyclically, damping fluctuations.

Table 1 reports estimates of equation (1) for the overall state and local budget balance as well as for expenditures and revenues separately (all excluding social insurance) for the periods 1959:2–1969:4 and 1970:1–1992:1.[6] For the first subperiod the estimate of β is negative, although insignificantly different from zero, implying that the state and local government sector played little or no role in damping fluctuations. The negative coefficient on expenditures, which indicates that spending (as a share of GDP) falls when output is above trend and rises when it is below trend, is almost exactly offset by a similar path for revenues.

For the second subperiod (the 1970s, 1980s, and early 1990s) the coefficient on the balance, at 0.083, is significantly different from zero at the 1 percent confidence level. Each 1 percent rise in the growth rate of GDP was associated with an increase in the surplus of 0.083 percent of GDP, in other words, helping to reduce the impact of aggregate

[6] We ran the regressions separately for these two subperiods because of the evidence of a structural shift discussed above. Regressions with and without allowance for a shift in the constant term in the mid-1980s, to take account of the surprising deterioration in state balances at that time, gave very similar results; those reported do not include the split constant term. Experiments with other functional forms, for example, including a time trend or a levels term in output, also produced similar results.

disturbances on the economy. This rise in the coefficient on the balance reflects a rise in the sensitivity of the ratio of expenditures to GDP over the cycle, together with a fall in the sensitivity of revenue.[7] The largest change is in the equation for revenues, where the estimate of β falls from a significant −0.104 before 1970 to an insignificant −0.029 thereafter.[8]

Is it possible that this change in the behavior of revenues reflects a change in the responsiveness to the cycle of federal grants rather than a change in state and local sector behavior itself? To test for this possibility, we reran the regressions dividing the revenue data into federal grants and revenues from own resources. Most of the change in the behavior of revenues is attributable to revenues from own resources, which is inconsistent with the aforementioned hypothesis. The estimate of β for revenues from own resources (not reported) fell from −0.072 to −0.023, and that on federal grants, from −0.032 to −0.010.

The change in the cyclical behavior of both expenditures and revenues plausibly reflects the transfer of fiscal responsibility from the federal to the state level. Prior to the 1970s, federal assistance to state and local governments mainly took the form of categorical grants with narrowly specified objectives.[9] The "New Federalism" of the Nixon administration aimed to give lower levels of government significantly more discretion over their use of federal money.[10] This transfer of fiscal responsibility could have encouraged state and local governments to take more account of the cycle when formulating budgets. One possible reflection of this change in priorities was the creation of explicit budget and economic stabilization funds. The first of these was set up by Michigan in 1977, which was then followed by 34 other states.[11]

[7] Since the balance reflects the difference between spending and revenues, this translates into an increased cyclical sensitivity of the balance. Note that a reduction in the sensitivity of the spending/GDP ratio to the cycle is equivalent to an increase in the sensitivity of the absolute level of real spending to the cycle. This is because GDP moves with the cycle; hence, a fixed ratio of spending to GDP implies a large cyclical element in actual spending.

[8] This is consistent with a move to a more medium-term budget perspective, with tax rates being kept relatively stable over the cycle. Feenberg and Rosen (1986) estimate that personal income and sales taxes, which make up the bulk of state (but not local) government revenues, have a combined elasticity of close to unity. This implies that, with unchanged tax rates, the ratio of revenues to nominal GDP would stay constant over the cycle.

[9] Swartz and Peck (1990).

[10] While the scope of federal assistance expanded in the 1960s, its administration remained essentially unchanged until the early 1970s, when the State and Local Assistance Act (1972) consolidated over 130 categorical grant programs into six block grants with significantly reduced fiscal controls.

[11] Details of the operation of these stabilization funds are contained in ACIR (1991). National Governors' Association (1992) reports their financial position.

II. Regional Evidence

The results reported above use data aggregated over all state and local governments. To further investigate behavior of different levels of government, individual-state data on state and local budget balances were collected from the Bureau of Census.[12] Given the change evident in the aggregate data around 1970, we limited the sample used in this section to the period 1971–90.[13] All fiscal variables were normalized by dividing by nominal gross state product (the regional equivalent of GDP) for the previous year and combined into the eight standard regions employed by the Bureau of Economic Analysis.[14]

Table 2 shows the results from reestimating equation (1). They indicate that state rather than local governments stabilize over the cycle. When the model is estimated as a system with β constrained to be equal across regions, its value is .077 and highly significant at standard confidence levels. In contrast, the coefficient in the local government regressions is .003 and insignificantly different from zero. At .080, the sum of the coefficients on state and local government is very similar to that produced by the quarterly NIPA data.

We also report values of β for each region when they are not constrained to be equal and the likelihood ratio statistic associated with the constraint. When the regional coefficients are freely estimated the results confirm the lack of importance of local governments in fiscal stabilization. The constraint of equality across the coefficients cannot be rejected, and only one of the freely estimated values differs significantly from zero. In contrast, the hypothesis of equality is rejected for state governments, indicating the existence of significant differences in behavior across regions. State budgets on the eastern seaboard (New England and the Mideast) and the Far West display relatively large cyclical offsets, with coefficients on the order of 0.11–0.14. The other western regions (the

[12]The state fiscal balance is defined as total government revenues minus total expenditures, while the local government fiscal balance is defined as total revenues less direct expenditures. These data are reported on a fiscal year basis, which generally start in July of the previous year. Despite the fact that state unemployment insurance trust funds are administered by the federal government, our consolidated state-level data were constructed to include them since they are likely to be sensitive to the cycle.

[13]Due to limitations of the available data, these local government regressions start in 1975. To conserve degrees of freedom, a time trend was substituted from the lagged dependent variable in the local government regressions reported below.

[14]New England, Mideast, Great Lakes, Plains, Southeast, Southwest, Rocky Mountains, and Far West.

Table 2. *Regional Results for State and Local Governments*

	State governments		Local governments	
	β	R^2	β	R^2
All Regions	.077**	.32–.75	.003	.16–.76
	(.010)		(.004)	
New England	.132**	.66	.016	.22
	(.043)		(.011)	
Mideast	.115**	.80	.035*	.40
	(.027)		(.016)	
Great Lakes	.070**	.70	−.005	.45
	(.013)		(.007)	
Plains	.040*	.33	−.003	.40
	(.016)		(.014)	
Southeast	.066**	.75	.002	.54
	(.013)		(.009)	
Southwest	.080**	.53	.013	.50
	(.018)		(.009)	
Rocky Mountains	.099**	.75	−.005	.76
	(.015)		(.010)	
Far West	.134**	.45	.015	.60
	(.023)		(.013)	
Likelihood ratio test of constraint ($\chi^2(7)$)	14.2*		9.0	

Notes: The equations were estimated using least squares. The first row shows the results when all of the β coefficients were constrained to be the same. The last row shows the results from testing this constraint using a likelihood ratio test. The state government equations were estimated over FY 1971–90; the local government data over FY 1975–90. The estimated coefficients on constant terms, lagged dependent variables, and time trends are not reported. One or two asterisks indicate the coefficient is significant at the 5 or 1 percent level, respectively.

Southwest and Rocky Mountains) have somewhat lower values (0.08–0.10), while the Midwest and South (the Great Lakes, Plains, and Southeast regions) have the smallest offsets, ranging from 0.040 to 0.070.[15]

Of the 50 states in the union, 49 have some sort of limits on the amounts and types of debt that they are legally allowed to issue. In addition, a number of states operate subject to statutes that limit deficits as well as debts. Some states are prohibited from carrying a deficit into the next

[15] All of these cyclical coefficients are significantly different from zero at the 1 percent level, confirming the result of the previous section that, over the period 1970–90, state governments have indeed provided significant regional automatic stabilizers.

fiscal year. In others, the governor must only sign a balanced budget; subsequent events that cause the fiscal balance to deteriorate do not require immediate action. In still other states the legislature must only pass a balanced budget. Some of these restraints are in the state constitution, while others are statutory.[16] The regions that are estimated to have relatively large cyclical offsets tend to be those with less stringent fiscal restraints, while those with smaller cyclical offsets have more stringent restraints. Many New England states have particularly weak fiscal restrictions; in the Far West, California, which dominates the region economically, also has relatively lax fiscal controls. In contrast, all of the states in the Plains region have relatively stringent restraints.

To further investigate the connection between legislative controls and countercyclical sensitivity, we repeated the regressions for state governments on a state-by-state basis. We then related the estimated values of β to an index of the stringency of state fiscal controls constructed by Anderson and ACIR (1987). This index, which varies from 0 to 10, attempts to summarize the severity of fiscal restraints on state governments. Of the 50 states, 26 have an index of 10, while 8 have a value of 5 or less; only Vermont has an index of 0, indicating no restrictions on borrowing. A regression of the estimated β coefficients on the index of controls produced the following:[17]

$$\begin{aligned} \text{COEF} &= 0.1361 - .0055\,(\text{FISCAL INDEX}) \\ &\qquad (0.0201)^{**}(.0024)^{*} \\ R^2 &= .10 \end{aligned}$$

The coefficient on the fiscal index differs from zero at the 5 percent level. Moving from no fiscal controls to the most stringent level of controls lowers the cyclical offset by 0.055. Given the estimated intercept of 0.136, this suggests that fiscal controls can have a sizable impact on stabilization, reducing the cyclical variance of the fiscal balance by about 40 percent of its original value. When the sample is limited to states with fiscal indices of 6 or more, which covers over four fifths of the full sample

[16] State-by-state details of these provisions can be found in *Significant Features of Fiscal Federalism*, an annual publication of the Advisory Council on Intergovernmental Relations (ACIR). Table 3 of ACIR (1991), for example, indicates that while governors must submit a balanced budget in 45 states, they are required to sign a balanced budget in only 34 states.

[17] Although the equation uses generated values from an earlier regression, the coefficient estimates are unbiased because the generated values are in the dependent variable. One asterisk signifies that the coefficient is significant at the 5 percent level; two asterisks signify that the coefficient is significant at the 1 percent level.

and eliminates the largest outliers, the estimated impact of fiscal controls is even larger; this indicates that the full-sample results if anything provide a conservative estimate of the effect.

Which component of the surplus—revenues or expenditures—is most strongly affected by restraints? To answer this question we reestimated equation (1) for revenues and expenditures separately. As with the overall surplus, the β coefficients obtained from individual state regressions were then regressed on the fiscal index. We also included the logarithm of the level of real state product on the grounds that state governments administer more programs directly in smaller states, which may also affect the cyclical behavior of revenues and expenditures. Most of the difference in behavior associated with fiscal constraints turns out to be on the expenditure side. The coefficient on the fiscal index in the expenditure equation is −.0045, as opposed to .0005 in the revenue equation. About 90 percent of the reduction in fiscal stabilizers associated with fiscal restraints occurs, in other words, through reducing the cyclical sensitivity of expenditures, a result that contrasts with the comparison between the periods before and after 1970 discussed earlier, where the main change was in the behavior of revenues.

In short, while some fiscal stabilization appears to be carried out by state governments, less is undertaken by states operating under relatively stringent fiscal restraints, mainly because of reductions in the cyclical sensitivity of their expenditures.

III. International Evidence

The results summarized above indicate a significant role for fiscal stabilization by state governments in the United States, a country whose fiscal structure is relatively decentralized. This finding raises the question of how the situation compares in other countries. Is greater responsibility for fiscal stabilization undertaken by the central government in countries with more unitary governments, or is less overall fiscal stabilization supplied?

To address this question we gathered data from the OECD *National Accounts* (various issues) for several large industrial countries. We distinguished net lending by central government and social security funds from that by lower levels of government.[18] Using data from 1970 to 1989 we

[18]To focus on the distinction between central and other levels of government the accounts for central government and social security funds were consolidated. It turns out that social security funds provide a significant level of stabilization in the United States and Germany but not in the other countries studied.

Table 3. *Estimates for OECD Countries*

Estimating Equation: $\Delta(BAL/GDP)_t = \alpha + \beta\Delta\ln_t + \tau(BAL/GDP)_{t-1} + \delta t$

	Central government (including social security funds)		Lower levels of government	
	REV/GDP	β	*REV/GDP*	β
Canada	.193	.34(.13)**	.181	.17(.06)*
Germany	.302	.33(.11)**	.138	.23(.04)**
United States	.202	.49(.13)**	.103	.08(.02)**
France	.399	.43(.11)**	.034	.01(.03)
Japan	.212	.31(.10)**	.061	.06(.03)
The Netherlands	.477	.47(.10)**	.031	−.01(.04)
Log likelihood test $\chi^2(6)$		8.1		20.0**

Notes: The equations were estimated using multiequation least squares on annual data over the period 1971–89. Estimated coefficients on the constant terms, lagged dependent variables, and time trends are not reported. One or two asterisks indicate the coefficient is significant at the 5 or 1 percent level, respectively. The likelihood ratio test is a test that all of the coefficients are equal.

estimated equation (1) (augmented by a time trend) for Canada, Germany, the United States, France, Japan, and the Netherlands.[19] The first three countries are federal states in which lower levels of government possess significant autonomy; the others have more unitary fiscal and political structures.

Table 3 summarizes the importance of revenues from own resources for central and lower levels of government as a proportion of nominal GDP. Own revenues accruing to lower levels of government are significantly higher in federal than unitary states, implying a higher degree of effective fiscal autonomy in the case of the former. Table 3 also reports estimates of β for the fiscal balances corresponding to these different levels of government. These indicate a difference in the extent of fiscal stabilization provided by lower levels of government in federal and unitary states. While the coefficients associated with output growth are large and significant for the three federal states in our sample (Canada, Germany, and the United States), those for unitary states are small, insignificant, and even incorrectly signed.[20]

[19]Models were also estimated for Sweden and the United Kingdom, but the results were unsatisfactory. This presumably reflects structural shifts in fiscal policy relationships.

[20]The estimates of β for the United States verify that our conclusion that the state and local government sector has operated a countercyclical policy is robust

There is a clear difference, moreover, between the estimated coefficients for lower levels of government in the United States on the one hand and in Canada and Germany on the other. In the United States, where borrowing by the state and local sector is widely constrained by statute and constitution, the elasticity of the state and local budget balance with respect to output is less than half of that for Canada and Germany, where comparable restraints do not apply. This is consistent with the evidence reported above that statutory and constitutional restraints significantly reduce the magnitude of fiscal stabilizers.[21]

The coefficients measuring the extent of the fiscal stabilization provided by central governments (including social security funds) are relatively similar across countries. All of these coefficients fall in the range from 0.3 to 0.5, and the hypothesis of equality across countries cannot be rejected. Given the marked differences in the stabilizers provided by lower levels of government (as described in previous paragraphs), this has two implications. First, countries with federal structures in which lower levels of government are subject to fiscal restraints enjoy significantly less automatic stabilization than countries with federal structures in which lower levels of government are unrestrained. Second, given the relatively small differences across countries in the extent of the automatic stabilization provided by central governments, federal states—including even the United States, where the magnitude of the stabilization provided by lower levels of government is somewhat lower due to legal restraints—enjoy a higher overall level of automatic stabilization than do countries with unitary structures.[22]

We also estimated the model separately for revenues from own re-

to alternative data sources. While central government (including social security funds) provides the bulk of the automatic stabilization, state and local government also plays a significant role. At .08, the estimated coefficient on the change in output for the fiscal balance of lower levels of government is very close to that derived from the preceding section on the basis of independently constructed data. Comparing the estimated coefficient for state and local government with that for central government, it appears that state and local government provided about one seventh of total automatic stabilizers over the 1970–89 period.

[21] Attempts to impose cross-equation restrictions confirm the significance of both the difference between federal and unitary states and that between the United States and the other two federal states. Likelihood ratio tests reject the restriction that the Canadian, German, and U.S. coefficients are equal, as well as rejecting equality across all countries.

[22] Similar results are reported by Jaeger (1993), who considers the cyclical response of the general government balance for the seven major industrial countries. Two federated states, Canada and Germany, have the largest responses, although, in contrast to our results, the other federated state, the United States, has the lowest response.

sources and for expenditures. There was little evidence of a pattern across countries. Although the β coefficients associated with central government revenues were generally small and insignificant, those for France and the Netherlands were around −0.3 and highly significant. The β coefficients on expenditures in these countries were correspondingly higher. These differences may reflect reliance on indirect tax revenues in these countries. Overall, it appears that the relatively predictable behavior of the total balance is consistent with a range of sensitivities of revenues and expenditures to output.

IV. Simulation Analysis

Underlying this discussion is the notion that fiscal stabilization can reduce the impact of macroeconomic shocks and hence that diminishing the cyclical sensitivity of those balances may increase the variability of output. This section provides evidence on these effects using MULTIMOD, a rational-expectations macroeconomic model developed at the IMF.

A version of MULTIMOD was developed in which the coefficient linking the U.S. government fiscal balance to output was set at 0.4, approximating the average of the central government responses reported in Table 3. Though the use of the U.S. model in the simulations was arbitrary, experiments with models for other countries indicate that the major conclusions carry over. We focus on a shock which might be thought of as a typical "business cycle" disturbance, namely, a temporary 5 percent fall in the propensity to consume.[23]

We started by running a standard simulation in which the level of real government consumption and the tax rate were left unchanged while the fiscal balance was allowed to vary freely. The simulation was then repeated with the fiscal balance fixed (by varying either government consumption or taxes net of transfers).

Results are reported in Table 4. The size of the initial shock to output rises, as expected, when the operation of the government balance is constrained. Importantly, the size of this change is dependent on the instrument that is used to eliminate movements in the fiscal balance. When government consumption is used, the initial fall in output

[23] Clearly, many other types of shocks could be analyzed. As a check on the robustness of the results, the analysis was repeated for an alternative shock, namely, a temporary rise in the short-term interest rate. The effect of the government balance on output was very similar across the two simulations, indicating that the precise shock is relatively unimportant for the results.

Table 4. *MULTIMOD Simulation of a Temporary 5 Percent Fall in the Propensity to Consume*

(Percentage deviation from baseline)

	1993	1994	1995	1996	1997
	Base case scenario				
Real GDP	−2.8	−0.4	0.9	1.1	1.0
Govt. deficit (billions of dollars)	−64.5	5.9	46.8	57.2	45.5
	Government consumption used to close budget gap				
Real GDP	−4.6	0.0	2.0	1.8	0.8
Govt. consumption (billions of dollars)	10.1	−0.9	−6.5	−6.2	−3.0
	Taxes net of transfers used to close budget gap				
Real GDP	−3.2	−0.2	1.2	1.3	0.9
Tax rate (percentage)	0.3	0.4	0.1	−0.1	−0.3

increases by about two thirds, from −2.8 percent to −4.6 percent. When taxes net of transfers are used, the increase in the change in output is smaller, from −2.8 percent to −3.2 percent. These differences reflect the different output multipliers associated with these different instruments in MULTIMOD.

While these results show the impact of completely eliminating fiscal stabilizers, fiscal restraints are more likely to reduce the responsiveness of the government balance to the cycle than to eliminate it altogether. Since the model is approximately linear it is possible to calculate intermediate variations by appropriately averaging the basic simulations. The results for U.S. state governments reported above indicate that fiscal restraints may reduce the sensitivity of the fiscal balance to the cycle by 40 percent, with most of the adjustment coming through expenditure restraint.[24] Assuming that this adjustment is divided between government consumption and taxes net of transfers in the ratio of 3:1, the implied shock to output is −3.4 percent [(0.6 × 2.8) + (0.3 × 4.6) + (0.1 × 3.2)]—an increase of over 20 percent from the case with freely acting fiscal stabilizers.

Our calculations thus indicate that if central government fiscal stabilizers fell by the percentage that we have estimated occurs in states with stringent fiscal restraints, the macroeconomic impact could be significant.

[24] As discussed in Section II above.

VI. Conclusions and Implications

This paper has considered the countercyclical role of the fiscal policies of different levels of government in the United States and other industrial countries, along with the impact offiscal restraints. For the United States we find that state budgets played a significant role in macroeconomic stabilization in the 1970s and 1980s, providing about one seventh of the total fiscal offset to income fluctuations. The rest was supplied by the federal budget and social security trust funds. Local governments played little or no role in cyclical stabilization. The pattern is broadly similar in the other federal states we consider—Canada and Germany. In countries with unitary governments, in contrast, the degree of fiscal stabilization provided by the central government is broadly comparable with that in the United States, but the countercyclical impact of the consolidated fiscal system is less because lower levels of government do not engage in significant stabilization.

We also find that the cyclical responsiveness of state budgets is significantly affected by fiscal restraints. The fiscal balance of U.S. states with stringent statutory and constitutional restrictions on deficit spending and debt issue varies less over the cycle. Simulations indicate that a reduction in national fiscal stabilizers of the magnitude we have estimated for U.S. state governments could lead to a noticeable increase in the variance of national output.

These findings have implications for each of the contexts in which the need for fiscal restraints has been mooted. In the United States, where the federal budget has played a significant macroeconomic stabilization role since 1970, a balanced budget amendment that caused the federal budget balance to mimic more closely that of states subject to strict statutory and constitutional restraints could noticeably diminish the federal budget's role in automatic stabilization. In Europe, where the Maastricht Treaty on Economic Union provides for ceilings (more precisely, "reference values") for the budget deficits of EU member states. strict enforcement could similarly diminish the stabilization afforded by national budgets. In a post-EMU Europe, the EU budget would in all likelihood remain small by U.S. standards. National budgets, in contrast, would be large by the standard of state budgets in the United States. If the provisions of the treaty prevent national governments from adjusting their budgets to the cycle, post-Maastricht Europe may enjoy significantly less fiscal stabilization and experience greater output volatility than has been the historical norm.

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External Shocks, the Real Exchange Rate, and Tax Policy

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This paper uses a computable general equilibrium model of the economy of Trinidad and Tobago to assess the effects of trade liberalization and terms-of-trade shocks on the real exchange rate and the overall fiscal position of the government. The model is also used to evaluate the implications of alternative tax policies designed to offset the increase in the budget deficit of the central government that results from both types of external sector shocks. [JEL C68, F13]

THROUGHOUT THE 1980s, many developing countries that depend heavily on the exports of a primary commodity or a natural resource, such as petroleum, have been forced to restructure as a result of fluctuations in the world price of their exportable good. Indeed, many of these countries adapted to their newfound wealth after discovery of a natural resource only to face the need for adjustment after the boom had subsided. The general consequences of resource booms, known as Dutch disease, have usually included "deindustrialization," real exchange rate appreciation, and a loss of competitiveness (see Corden and Neary (1982) and Corden (1984) for relevant surveys). As the boom proceeds, the booming sector expands and draws resources away from other sectors of the economy, usually other traded, import-competing sectors and some nontraded sectors, as these sectors must contract to free inputs to the booming sector; thus, deindustrialization results. The newfound wealth translates into increased spending on all goods, and this spending effect

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will increase the prices of nontraded goods, introducing an appreciation of the real exchange rate and a loss of competitiveness as the prices of traded goods (exogenous for a small country) fall relative to the prices of nontraded goods.

Against this background, many small, primary commodity exporting countries have had to adjust to the consequences of Dutch disease. A typical response to the restructuring inherent in a boom has been to resort to a policy of protection, as in the case of Trinidad and Tobago. In the late 1970s and early 1980s, the economy experienced a major expansion in the petroleum sector as the international price of petroleum rose sharply. In the wake of this boom, the economy maintained its protectionist environment of high tariffs and expanded the number of imported goods contained on the "negative list" in an effort to shield domestic import-competing industries from the effects of the real appreciation induced by the rise in the international price of oil. The expansion of import protection, designed to sustain output and employment in the import-competing sectors, further exacerbated the loss of competitiveness because protection causes an appreciation of the real exchange rate. Only recently has the economy begun to liberalize its trading regime in the hope of restoring competitiveness and promoting exports.

Trade liberalization has had important beneficial effects on the economy of Trinidad and Tobago, most notably, a restoration of competitiveness through real exchange rate depreciation. The effects of trade liberalization on the overall position of the public sector are less clear, however, and this aspect of trade liberalization is important because the central government's recourse to additional financing is clearly limited. The effect of trade liberalization on the fiscal position of the government has become an important issue, but according to Blejer and Cheasty (1988), Tanzi (1989), and Feltenstein (1992), no definite conclusions can be reached a priori concerning the direction of the change in the fiscal position from trade liberalization. According to Tanzi, there is a presumption that trade liberalization will improve the fiscal position of the government, but the papers by Blejer and Cheasty and by Feltenstein are less definite on this point, especially Feltenstein, who finds that trade liberalization would worsen the fiscal position of Mexico.

Given this uncertainty, an empirical investigation of trade liberalization is appropriate. While trade liberalization may help restore competitiveness, if it worsens the budget deficit, it may also impede the economic adjustment necessary to promote growth in the economy. Trade liberalization will usually result in lower tariff revenue, but there are also indirect, sometimes positive, effects on revenue from other types of taxes, such as value-added taxes and export taxes. For example, in

economies that derive revenue from the taxation of exports, liberalization of trade will increase revenue from that source because the real exchange rate depreciation that results from trade liberalization will increase exports. This effect may offset, to some degree, any loss in tariff revenue. In addition, if the consumption of imports is also subject to a consumption tax, such as a value-added tax, a reduction in tariff rates will increase import volume and so will generate additional revenue. However, the existence of a complex tax regime means that the effect of trade liberalization on the fiscal position is complicated, so it is necessary to examine this issue using a fully specified, applied general equilibrium model.

The purpose of this paper is to determine the effects of two types of external shocks—trade liberalization and changes in the terms of trade—on the real exchange rate, trade flows, and the fiscal position of the economy of Trinidad and Tobago using a computable general equilibrium model. The model is sufficiently general to be applied to other small, open economies, and is applied to Trinidad and Tobago to demonstrate the methodology and usefulness of the technique. The technique adopted in this paper—applied general equilibrium modeling—is especially appropriate for analyzing the effects of changes in commercial policy and terms-of-trade shocks because of its ability to capture directly the important relative-price effects of various shocks; both types of shocks undertaken here involve changes in relative prices.[1]

In this paper, the model is used to perform three broad tasks: quantify the effects of trade liberalization on the performance of the fiscal and external sectors under different assumptions concerning the flexibility of the price of nontraded goods; quantify the effects of an adverse shift in the terms of trade and evaluate the effects of alternative policy responses to this shock; and rank the effects on efficiency of alternative tax policies designed to prevent an increase in the budget deficit following both types of external shocks. It should be emphasized that the analysis in this paper is static and does not consider how the various external shocks affect the economy over time.

[1] While other types of modeling techniques, such as macroeconomic modeling, could conceivably be used, these types of models do not usually capture resource constraints, material balance constraints such as market clearing, and other elements grounded in general equilibrium microeconomic theory. In this paper, the focus is on the relative-price and welfare effects of changes in policy, rather than on the effects of external shocks on aggregate spending, output, and inflation. Inclusion of a monetary sector, for example, would not help reveal the inefficiencies of trade barriers, the existence of which is a central message of the paper.

I. Structure of the General Equilibrium Model

This section contains a description of the general equilibrium model used to assess the impact of alternative trade and tax policies on the economy of Trinidad and Tobago. The model is a static, applied general equilibrium model of a small, open economy of the type used by Clarete and Roumasset (1987), Clarete and Whalley (1988), and Benjamin, Devarajan, and Weiner (1989), and explained in detail by Dervis, de Melo, and Robinson (1982) and Shoven and Whalley (1984).[2] The model is designed to compute the equilibrium real exchange rate—an important relative price defined as the ratio of the price of tradables to that of nontradables—that results from changes in exogenous variables and to provide an estimate of the effects of alternative trade and tax policies on the volume of imports and exports and on the surplus or deficit of the central government. Devarajan, Lewis, and Robinson (1991) use a much simplified structure—a version of the Salter-Swan model—to show the usefulness of this type of model for calculating the new equilibrium real exchange rate that results from changes in commercial policy.

The model divides the economy into three sectors: exportable, importable, and nontraded or home good. For Trinidad and Tobago, the exportable sector is made up of mainly petroleum products.[3] The importable sector consists of labor-intensive manufacturing activities, while the nontraded sector is comprised of services and construction activities. It is assumed that Trinidad and Tobago is a "small country" and therefore the terms of trade (the relative price of the exportable to that of the importable) are exogenous. In contrast, the price of the nontraded good is determined locally by domestic demand and supply.

Each of the goods in the model is produced by combining three inputs: labor, capital, and imported intermediate inputs. The production process is assumed to take place in two stages. In the first stage, a representative firm in each of the three sectors hires an amount of labor up to the point where the value of the marginal product of labor equals the wage rate. In contrast, capital is assumed to be sector-specific, so the return to capital is a residual after labor is paid the value of its marginal product. Thus, in this first stage, labor and capital are combined to form value added by sector. In the second stage, value added is combined, in fixed proportions, with imported intermediate inputs to produce gross output by

[2]For an analysis of the effects of trade policy in a dynamic general equilibrium model, see Ho and Jorgenson (1993) and Lee (1993).

[3]Exports of petroleum and related products such as petrochemicals accounted for slightly more than 77 percent of exports in 1991.

sector. The supplies of both labor and capital are fixed, so wages and rents adjust to bring about equilibrium in factor markets. Labor is fully mobile across sectors, whereas capital is sector specific.[4]

The government is assumed to collect taxes from a variety of sources. Government revenue consists of receipts from import taxes, a value-added tax, petroleum taxes, income taxes, and a broad category covering all other taxes. The government consumes some of all three goods, but its expenditure is assumed to remain fixed in real terms. The resulting surplus or deficit of the central government is equal to total government revenue less government spending.

The economy consists of a representative household that exhibits preferences over the three goods described by a Stone-Geary utility function. The representative household receives income from ownership of labor and capital and purchases the output of the three sectors with this income. The demand for imports is the excess of total domestic demand for the importable good over domestic production, while the supply of exports is the excess of domestic production of the exportable good over domestic consumption. The price of the nontraded good is assumed to adjust to bring about equilibrium in the market for the nontraded good. Thus, equilibrium will be determined when a set of relative prices is found so that the market for nontraded goods clears. The following sections describe the equations of the model in detail.

Production and Factor Markets

The domestic production process for all three goods consists of two levels of nesting. At the first level, labor and capital are combined to produce value added on a sectoral basis according to a constant elasticity of substitution aggregation function:

$$VA_j = AX_j[\alpha_j L_j^{-\Omega_j} + (1 - \alpha_j)K_j^{-\Omega_j}]^{(-1/\Omega_j)}, \quad (1)$$

where VA_j denotes value added in sector j (j = exportable, importable, and nontraded sectors), AX_j and α_j are constants, L_j and K_j are the quan-

[4]This type of production structure is appropriate for an analysis of oil production. The assumption of fixed capital stocks reflects the fact that capital cannot be shifted into other sectors of the economy. Allowing for the use of imported intermediate inputs is also appropriate since most of the capital goods needed are not produced domestically. The oil sector can, however, compete with other sectors of the economy for labor. Finally, the scope for substitution between inputs, especially between value added and intermediate inputs is quite limited; hence, the choice of a Leontief technology is appropriate.

tities of labor and capital needed to produce good j, and $\Omega_j = (1 - \phi_j)/\phi_j$, where ϕ_j is the elasticity of substitution between capital and labor in the production of good j.

At the sectoral level, value added consists of payments to both labor and capital. Specifically,

$$PVA_jVA_j = WL_j + R_jK_j, \tag{2}$$

where W is the wage rate, PVA_j is the value-added price, K_j is the stock of capital installed in sector j, and R_j is the return to capital in sector j. Since capital is sector specific, its return will differ across sectors and is computed as a residual after labor is paid the value of its marginal product. The demand for labor by a particular firm depends on the value of the marginal product of labor, which equals the value-added price multiplied by the marginal product of labor. A firm will hire an amount of labor up to the point where the value of the marginal product of labor equals the wage rate, as given by

$$W = (\partial VA_j/\partial L_j)PVA_j. \tag{3}$$

At the second level of nesting, value added is combined with imported intermediate inputs in fixed proportions to produce gross output. Demand by the firm for value added and imported intermediate inputs is given by

$$VA_j = \alpha_{VA} X_j \tag{4}$$

and

$$MI_j = \alpha_I X_j, \tag{5}$$

where α_{VA} is the amount of value added required per unit of output X_j; α_I is the amount of imported intermediate inputs required per unit of output; and MI_j is the amount of imported intermediate inputs used to produce good j. The value of output equals the total cost of production:

$$PX_jX_j = PVA_jVA_j + PMI\ MI_j, \tag{6}$$

where PX_j is the output price of the jth good and PMI is the price of imported intermediate goods. The price of imported intermediate goods is determined by

$$PMI = PWI_M(1 + TMI), \tag{7}$$

where PWI_M is the world price of imports, which is fixed relative to the numeraire, and TMI is the ad valorem tariff rate on imported intermediate inputs. An increase in the tariff rate on imported intermediate inputs will thus increase the cost of producing a given level of output.

In the factor markets, the sectoral demand for labor is determined by equation (3). Total demand for labor is the sum of each sector's demand for labor. The supply of labor is assumed to be invariant with respect to the wage rate, as in the theoretical models of trade such as Jones (1965, 1971) and Mussa (1974), and in the applied model of Khan and Montiel (1987), for example. Labor is assumed to be perfectly mobile across all three sectors, so labor earns the same return regardless of sector of employment. Therefore, equilibrium in the labor market is given by

$$\sum_j L_j = \bar{L}, \tag{8}$$

where $\bar{L}$ is the fixed endowment of labor. Concerning capital, the model adopts a Ricardo-Viner-type structure in that capital is assumed to be sector specific:

$$K_j = \bar{K}_j, \tag{9}$$

where $\bar{K}_j$ is the fixed stock of capital by sector. This assumption is appropriate because the model is not dynamic, so there is no investment. Since capital is sector specific, its return is a residual after labor is paid the value of its marginal product; this residual payment is determined by equation (2).

Government Revenue and Spending

The model contains a rich array of tax instruments, including a tariff on imports, a value-added tax, a petroleum tax, and income taxes. There are two tariff rates applicable to imports: a tariff on imports for consumption and a tariff on imports of intermediate goods. Tariff revenue collected on imports of consumption goods is determined by

$$TARIFF = t_M PW_M MD, \tag{10}$$

where $TARIFF$ is tariff revenue, t_M is the tariff rate, PW_M is the world price of imports, and MD is the volume of import demand for consumption. Similarly, tariff revenue from imports of intermediate goods is given by

$$ITARIFF = TMI\ PWI_M \sum_j MI_j, \tag{11}$$

where $ITARIFF$ is revenue from tariffs on imported intermediate goods.

Revenue from taxes on labor income is given by

$$YTAX = t_y \left(\sum_i WL_i \right), \tag{12}$$

where $YTAX$ is revenue from taxes on labor income and t_Y is the tax rate. Revenue from petroleum taxes is given by

$$OILTAX = RN_X t_p K_X, \tag{13}$$

where $OILTAX$ is petroleum tax revenue, RN_X is the net return to capital in the exportable (petroleum) sector, and t_p is the tax rate. Since capital is assumed to be sector specific, the petroleum tax is modelled as a tax on profits (return to capital) in the petroleum sector. The net-of-tax rental rate on capital in the petroleum sector is related to the gross-of-tax rental rate R_X by

$$R_X = RN_X(1 + t_p). \tag{14}$$

Revenue from the value-added tax is given by

$$VATR = t_V[(PX_M X_M + PX_M MD) + PX_{NT} X_{NT})], \tag{15}$$

where $VATR$ is revenue from the value-added tax and t_V is the value-added tax rate. The model assumes that the value-added tax applies to consumption of the importable and the nontraded good; the value-added tax is not levied on the exportable. In the import-competing sector, the gross-of-tax consumption price PD_M is determined by

$$PD_M = PX_M(1 + t_V) \tag{16}$$

Similarly, the gross-of-tax consumption price of the nontraded good is

$$PD_N = PX_N(1 + t_V). \tag{17}$$

Government revenue, GR, is the sum of all the various components of revenue described in equations (10)–(13) and (15) and is given by

$$GR = TARIFF + ITARIFF + YTAX + OILTAX + VATR. \tag{18}$$

In the model, the behavior of the government is modeled very simply. Government expenditure consists of spending on goods, interest payments, and transfers. The overall government budget deficit or surplus is the difference between government revenue and government expenditure:

$$GBAL = GR - PD_N GD_N - PW_M GD_T - IRATE * DEBT - TRANSF, \tag{19}$$

where $(PD_N GD_N)$ is government expenditure on nontraded goods; GD_T is government consumption of traded goods (in units of the numeraire PW_M); $IRATE$ is the exogenously determined interest rate; $DEBT$ denotes the amount of government debt; and $TRANSF$ is government transfers.[5] Real government demand for traded goods (GD_T) and the nontraded good (GD_N) is assumed to be fixed.

Aggregate Income and Demand

Total domestic demand for all three goods is the sum of consumer demand and government demand. Consumer demand functions for each type of good are obtained by maximizing individual utility subject to a budget constraint. The representative consumer maximizes a Stone-Geary utility function, which takes the following form:

$$U = (D_M - \lambda_M)^{\beta_M}(D_X - \lambda_X)^{\beta_X}(D_N - \lambda_N)^{\beta_N}, \tag{20}$$

where U denotes the level of utility; D_j is the demand for good j; λ_j is the minimum or subsistence level of consumption of good j; and β_j is the marginal budget share of good j. Total income available for consumption, Y, is the sum of labor and capital income, the budget surplus, and the trade deficit:

$$Y = \sum_j (WL_j + RN_j KD_j) + GBAL - TBAL, \tag{21}$$

where $TBAL$ denotes the trade balance.[6] Disposable income equals total income Y less income taxes, plus government transfers:

$$DY = (Y - YTAX + TRANSF), \tag{22}$$

where $TRANSF$ is government transfer payments. Maximization of equation (20) subject to the consumer's budget constraint gives the following familiar form for the demand functions:

[5]The stock of government debt and the volume of transfers are fixed in real terms.

[6] Equation (20), which defines income, Y, should not be confused with GNP. In equation (20), Y denotes the amount of "money" available for the consumer to spend before taxes and transfers. If the government runs a surplus, then the amount of money available for the consumer to spend rises, as the government is assumed to return the surplus to the representative consumer. Similarly, if there is a trade deficit, the rest of the world is willing to lend, as domestic consumption exceeds income. This inflow of foreign lending (a capital inflow) represents resources available to the representative consumer, so it is included in the definition of Y. This is the approach adopted in Dervis, de Melo, and Robinson (1982), de Melo and Tarr (1992), and Rousslang and Tokarick (1995).

$$D_j = \lambda_j + (\beta_j / PD_j)\left[DY - \sum_j PD_j \lambda_j\right], \tag{23}$$

which shows that quantities demanded of each good depend on prices and disposable income. Finally, GNP is defined in the usual manner as

$$GNP = C + I + G + X - M, \tag{24}$$

where C is aggregate private consumption, G is government consumption, and $(X - M)$ is the trade balance.[7]

The External Sector

The model consists of two sectors that produce tradable goods: exportables and importables. The model adopts the "small country" assumption for Trinidad and Tobago, so the terms of trade, or the relative price of the exportable to the importable

$$TOT = \frac{PW_X}{PW_M} \tag{25}$$

is assumed to be exogenous. The supply of exports to the rest of the world and the demand for imports are both determined as residuals. The supply of exports to the rest of the world equals total production less private demand and government demand:

$$EX = X_X - D_X - GD_X. \tag{26}$$

Total demand for imports for consumption is simply the excess of private demand and government demand over domestic production:

$$MD = D_M + GD_M - X_M. \tag{27}$$

The domestic producer price of exports PX_X is related to the international price PW_X by

$$PX_X = PW_X(1 + S), \tag{28}$$

where S is the subsidy rate applied to exports. For the importable good, the domestic producer price PX_M equals the world price PW_M multiplied by one plus the ad valorem tariff rate

$$PX_M = PW_M(1 + t_M). \tag{29}$$

[7]Since the model is static, there is no investment ($I = 0$).

The trade balance (deficit or surplus) is the value (at world prices) of exports minus the value of imports:

$$TBAL = PW_X EX - PW_M MD - \sum_j PWIMI_j. \quad (30)$$

For most simulations undertaken in this paper, it is assumed that the real exchange rate (the price of traded goods relative to the price of the nontraded good) adjusts to clear the market for the nontraded good and the trade balance remains unchanged (capital inflow is constant). This assumption is adopted to reflect the fact that the country's recourse to borrowing is limited. Thus, holding the trade balance constant imposes a borrowing constraint on the economy.

Model Closure

General equilibrium exists when a set of relative prices is found such that all the model equations are satisfied. For all markets, prices adjust to equate quantity demanded with quantity supplied. The market-clearing equation for the nontraded goods market is

$$D_{NT} + GD_{NT} = X_{NT}, \quad (31)$$

so the price of the nontraded good will adjust to bring about equilibrium in the market for the nontraded good.

The terms of trade are exogenous, since it is assumed that Trinidad and Tobago is unable to affect the terms of trade by the amount it buys or sells internationally. The domestic prices of traded goods differ from the world prices by the applicable taxes. Since there is no money in the model, the model can only determine relative prices, rather than absolute prices. All demand and supply functions are homogeneous of degree zero in prices, so prices can be normalized in any fashion. The world price of importables, PW_M, is taken to be the numeraire, so its price is fixed at one.

As implied by Walras' Law, one equilibrium condition may be dropped because it can be deduced from the other equilibrium conditions. In this model, the equation defining the trade balance is dropped because it will be satisfied automatically if all the other equilibrium conditions hold. As a check on the internal consistency of the model, the trade balance was computed after each experiment and compared with its initial (pre-experiment) level. For every experiment performed, the trade balance computed from the model solution matched the initial trade balance, so Walras' Law was satisfied. The equations of the model represent a system with an equal number of equations and unknowns.

II. Parameters and Elasticities

Parameter Calibration

The model uses data for 1991 to determine the values for all the exogenous variables and parameters.[8] To determine unknown parameter values, the model employs the technique of calibration, described in Mansur and Whalley (1984), which is standard practice in applied general equilibrium modeling. Calibration involves using data on exogenous and endogenous variables in the base year to "solve for" unknown parameter values. This means that the model will replicate the base year data exactly; that is, the model will produce values for all the endogenous variables that match the observed values. For example, equation (10) defines tariff revenue. Data exist on the value of tariff collections and on the value of imports, so the tariff rate that is consistent with these data can be calculated by dividing the value of tariff revenue by the value of imports. A similar procedure is followed in calculating other unknown parameter values.

Elasticities

The model requires a number of elasticity values that are exogenous to the model. First, the model requires values for the elasticities of substitution between labor and capital in production. The values used for these elasticities (0.8 in the importable sector, 0.5 in the exportable sector, and 0.5 in the nontraded sector) were taken from the study by Maxwell Stamp (1992).

The second type of elasticities needed is elasticities of demand. As mentioned above, the representative consumer maximizes a Stone-Geary utility function, which gives rise to demand functions for the three goods of the form given in equation (23). Values for the parameters in the three demand functions, λ_j and β_j, are chosen to give a specified set of price and income elasticities of demand, as shown in Table 1.

Since there are three consumer goods, there are three income elasticities of demand, a 3x3 matrix of compensated demand elasticities, and a corresponding 3x3 matrix of uncompensated demand elasticities. The

[8]The data on production, employment, and value added were provided by the Central Statistical Office, Trinidad and Tobago. Data on the fiscal accounts were provided by the Western Hemisphere Department of the IMF. All remaining information was taken from the trade policy study by Maxwell Stamp (1992).

Table 1. *Base Case Elasticity Values*

	Imports	Exports	Nontraded
Compensated demand elasticities (μ_{ij}):			
Imports	−0.88	0.07	0.81
Exports	0.20	−0.45	0.25
Nontraded	0.30	0.03	−0.33
Uncompensated demand elasticities (ϵ_{ij}):			
Imports	−1.30	−0.08	−0.34
Exports	0.07	−0.50	−0.11
Nontraded	0.10	−0.04	−0.86
Income elasticities (η_i):	1.72	0.54	0.80

procedure adopted to determine these elasticities is as follows. First, values for the income elasticity of demand for the exportable and the nontraded good were chosen to be consistent with the values used in the study by Maxwell Stamp (1992). The third income elasticity was determined by the Engel aggregation condition, as only two of the three income elasticities are independent. This procedure determines each β_j, since from equation (32), the income elasticity of demand for good j takes the form

$$\eta_j = \frac{\beta_j}{S_j}, \tag{32}$$

where S_j is the share of income spent on good j. Thus, each β_j determines the income elasticity in the initial equilibrium, along with the expenditure share.

Given that each β_j is determined by the income elasticities, each λ_j must be determined. The values chosen for λ_j must satisfy each demand function, as given in equation (23), for the values of β_j. To determine each λ_j, two of the three demand functions are used together with the expression for the uncompensated own-price elasticity of demand for the exportable, which is given by

$$\epsilon_{XX} = \frac{-\beta_X \lambda_X}{D_X}, \tag{33}$$

where ϵ_{XX} is the uncompensated own-price elasticity of demand for the exportable. The value chosen for the price elasticity of demand for petroleum is −0.5, as suggested by Singer (1983) and the U.S. Department of Energy (1985). Thus, using this procedure, values for all six unknown parameters are determined. Once the values for λ_j and β_j are

determined, values for the income elasticities can be computed from equation (32) and values for the uncompensated demand elasticities can be computed from equations analogous to equation (33). Once the income and uncompensated demand elasticities are known, the compensated elasticities of demand are computed by using the Slutsky equation. The complete elasticity matrices shown in Table 1 satisfy all of the necessary restrictions from consumer theory. For example, the demand functions are homogeneous of degree zero in prices, so the row sum of the compensated demand elasticities is zero.

III. Policy Experiments

In the first set of experiments, the model was used to calculate the new equilibrium real exchange rate that results from the proposed trade reform program.[9] This program of trade reform consists of two major parts. First, the average nominal rate of protection applied to imports was reduced from 52.7 percent to 10.5 percent.[10] In addition, the trade reform program contains a 5 percent tariff on imported intermediate inputs. In these experiments, the effects of the trade reform program are calculated for two cases: the case in which the price of the nontraded good is fixed and that in which the price of the nontraded good is flexible. Comparing the results from these two scenarios highlights the role played by the price of the nontraded good in the adjustment process. Also, the model is used to quantify the efficiency effects of two alternative tax policies designed to offset the loss in government revenue from trade liberalization.

In the second set of experiments, the model is used to quantify the effects of a deterioration in the terms of trade on all the endogenous variables, noting especially the effects on trade flows and the overall fiscal position of the government. Over the last decade, adverse movements in the terms of trade suggest tbat the economy of Trinidad and Tobago has suffered a substantial contraction of its exportable sector.[11] A policy of trade liberalization will promote production of exportables because it induces a real exchange rate depreciation—a rise in the price of traded goods relative to the price of the nontraded good.

[9]The Government of Trinidad and Tobago has begun to implement the proposed program of trade liberalization.

[10]See Maxwell Stamp (1992), p. 324. The initial nominal rate of protection of 52.7 percent includes the effects of the Common External Tariff, quantitative restrictions, and stamp duties.

[11]In 1980, output of petroleum and petrochemicals accounted for 39 percent of GDP, while in 1991 their share was 23 percent.

In another component of these experimcnts, the model is used to evaluate the effects of compensatory tax policies designed to offset the revenue lost from a deterioration in the terms of trade. A deterioration in the terms of trade induces a fall in exports and, with it, a reduction in production and exports of petroleum. Since the government taxes profits in the petroleum sector, a terms-of-trade deterioration reduces oil-tax revenue. Specifically, the model is used to quantify the relative efficiency effects of increasing the value-added tax rate alone or an increase in the value-added tax rate combined with a tax on the production of the exportable good to replace the revenue lost from the terms-of-trade deterioration.

In all of these experiments, an important objective is to determine the new equilibrium real exchange rate that results from the proposed trade reform program, terms-of-trade changes, and changes in tax policy. Consistent with the literature, we define the real exchange rate to be an index of the international prices of traded goods relative to the price of the nontraded or home good, expressed in the same currency.[12]

IV. Results

This section presents the results from the simulation experiments described above, focusing on the effects of external shocks on trade flows, the real exchange rate, and the overall fiscal position of the government. The experiments performed are simple comparative static experiments. First, the set of equations describing the behavior of the model is solved. The resulting values for all the endogenous variables will replicate the values for the endogenous variables in the base year, so this represents a check of the calibration procedure and the programming. Next, a policy parameter—a tax rate, for example—is altered and the equations of the model are solved again. The values for all the endogenous variables that result from this solution are compared with the initial values of all the endogenous variables, and the differences between these values represent the effect of the policy change.

[12] The real exchange rate calculations use the price of traded goods inclusive of tariffs, where the price of traded goods consists of an aggregation of the price of importables and exportables. Alternatively, two real exchange rates could be computed: the importables real exchange rate, defined as P_M/P_N and the exportables real exchange rate, defined as P_X/P_N. Jones (1974), Edwards (1988), and Khan and Ostry (1991) show that protection will cause the importables real exchange rate to depreciate (a rise in P_M/P_N), while the exportables real exchange rate appreciates (P_X/P_N falls). Hence, protection introduces a bias against exports.

Results of Experiment 1: Trade Liberalization

In this experiment, the model is used to determine the effects of the government's trade reform program. This program represents a reduction from 52.7 percent to 10.6 percent in the nominal rate of protection applied to imports of final goods and the imposition of a 5 percent tariff on imports of intermediate products. To demonstrate the role played by the real exchange rate in the adjustment process, the results of this experiment are provided in Table 2 for two cases: the case in which the price of the nontraded good is inflexible, and the case in which the price of the nontraded good is flexible.[13] Of course, when the price of the nontraded good is inflexible, the trade balance is endogenous; if the price of the nontraded good is flexible, then the trade balance remains unchanged. As shown in Table 2, the proposed program of trade reform would increase consumer welfare in the economy.[14] This happens because the price of the importable good falls as a result of the reduction in the tariff, so consumption of the importable good increases. In production, the reduction in the price of imports induces a contraction in both output and employment in the importable sector. As a result, the wage falls when P_N is flexible, since the production of imports is labor intensive. This result is a straightforward application of the Stolper-Samuelson theorem (1941).[15] The reduction in the tariff on imports of final goods contributes to a more efficient allocation of resources and an increase in consumer welfare, even though the tariff on imported, intermediate inputs is increased.

The degree of flexibility in the price of the nontraded good plays an important role in the ultimate effects of trade reform, a point that has been emphasized by Dornbusch (1974).[16] A change in the price of the nontraded good, that is, a reduction in P_N, is necessary for the full effects of trade reform to be realized. When P_N is fixed, the increase in exports from tariff reduction is much smaller than when it is flexible. When P_N is fixed, tariff reduction results in a dramatic increase in imports, given

[13] Certain institutional features of the economy of Trinidad and Tobago may make price lexibility unlikely. For example, the existence of administered prices is not consistent with the flexible price scenario. Furthermore, the two cases presented in the paper represent polar extremes and the actual degree of price flexibility may fall between the two.

[14] Consumer welfare is measured by the equivalent variation, which is described in the result tables.

[15] This result is also consistent with the conclusions reached in Mussa (1974) and Jones (1971).

[16] Alam and Rajapatirana (1993) stress that trade reform should be preceded or accompanied by a real depreciation—a reduction in the price of nontraded goods relative to traded goods.

Table 2. *Effects of Trade Liberalization*
(Millions of 1991 TT dollars unless otherwise noted)

	Base case	Effects of trade liberalization	
		P_N fixed	P_N flexible
Real output			
Importables	2,130.2	1,249.2	1,536.5
Exportables	8,607.7	8,704.6	9,186.7
Nontraded	13,568.2	14,163.6	13,543.4
Government revenue	6,673.4	6,787.6	6,278.6
Oil tax	2,504.9	2,522.4	2,809.6
Tariff			
Final goods	544.8	440.6	213.3
Intermediate goods	0.0	179.6	191.6
VAT	1,051.7	1,151.3	831.8
Labor income tax	1,474.0	1,395.6	1,134.3
Other	1,098.0	1,098.0	1,098.0
Government expenditure	6,761.1	6,761.1	6,689.5
Government balance	−87.7	26.5	−410.9
Export volume	6,702.7	6,741.8	7,478.1
Import volume			
Final goods	1,033.8	4,156.4	2,012.4
Intermediate goods	4,035.2	3,592.7	3,832.0
Trade balance	1,633.7	−1,007.3	1,633.7
Percent change in real wage	—	1.5	−2.5
Equivalent variation[a]	—	4,015.6	353.1
(percent of base-year GDP)	—	17.5	1.5
Real exchange rate index[b]			
(percentage change)	—	−2.1	24.8

[a]The equivalent variation is computed by: $EV = E(P^0, U^1) - E(P^0, U^0)$, where $E(P, U)$ is the expenditure function, U^0 is the initial level of utility, U^1 is the new level of utility, and P^0 is the vector of initial prices.

[b]The real exchange rate index is computed by dividing a weighted average of traded goods prices (inclusive of tariffs) by the price of nontraded goods. A positive value indicates a real depreciation. The formula for the real exchange rate is

$$RER = \frac{(0.09PW_M(1 + t_M) + 0.57PW_X + 0.34PWI)}{P_N}.$$

the large reduction in the price of imports; however, no further price adjustments take place since both P_X and P_N remain unchanged. The increase in exports is relatively minor because while the reduction in the tariff reduces wages and therefore cuts the cost of production of the exportable, production of the exportable is not very labor intensive.

Flexibility in the price of the nontraded good provides an additional channel through which an expansion in exports can take place. As the demand for imports is price elastic, tariff reduction causes expenditure on imports to increase. For a given level of income, expenditure on other goods, including the nontraded good, must fall, so the price of the nontraded good falls. Also, because imports and the nontraded good are substitutes in demand, tariff reduction contributes further to the reduction in P_N by inducing a reduction in the demand for the nontraded good. This reduction in P_N provides an incentive for exports to increase further, as both (P_X/P_M) and (P_X/P_N) rise, making the production of exports more profitable and providing an incentive for resources to move into the exportable sector.[17] As a result, the increase in exports that occurs when P_N is flexible is much larger than when P_N is fixed. This is why the trade deficit increases substantially when P_N is fixed, compared with the case in which P_N is flexible and the trade balance is unchanged.

When P_N remains fixed (the second column in Table 2), the increase in welfare that results from trade liberalization is much larger than when P_N is flexible (the third column in Table 2). This is because when P_N is fixed, the balance of trade worsens as consumption of imports rises dramatically and the real exchange rate appreciates. The welfare gain that results when P_N is rigid is unrealistic, as it assumes that there is no limit to the amount that the economy can borrow from the rest of the world, so welfare increases dramatically as consumption increases. However, the large welfare gain is belied by the fact that the deficit will have to be repaid in the future, which is likely to require that the economy run trade surpluses just to meet the interest payments alone. The results from this case also suggest the need for a nominal exchange rate adjustment as part of the trade reform program. The large increase in the trade deficit is likely to be unsustainable and unrealistic to finance, so a nominal exchange rate adjustment may be necessary. In the case in which P_N is flexible, the economy faces an external borrowing constraint and P_N adjusts to ensure that this constraint is satisfied. Therefore, the welfare

[17] A reduction in the tariff on imports causes exports to expand because it increases the relative price of exportables to importables, as noted by Lerner (1936). A tax on imports is symmetrical to a tax on exports, so import liberalization increases exports.

gain from trade liberalization is much smaller when P_N is flexible, compared with when P_N is fixed, as the economy's ability to borrow from abroad is limited.

As shown in Table 2, the changes in relative prices that result from trade reform have important effects on the economy's performance. For example, trade reform leads to an increase in exports because the price of the exportable good rises relative to the price of the nontraded good. If P_N is flexible, this adjustment in relative prices will occur automatically through a reduction in the nominal price of the nontraded good. However, if the price of the nontraded good is rigid downward, then the necessary adjustment in relative prices will not occur.[18] If the price of the nontraded good is rigid, then there is scope for a nominal devaluation, which would facilitate the required adjustment in relative prices by increasing the prices of traded goods. Thus, a nominal devaluation would be a useful complement to a policy of trade liberalization when the price of the nontraded good is inflexible.

Concerning the effects on the fiscal position, trade reform generates an increase in the government deficit, a finding that is consistent with Feltenstein (1992), but does not coincide with that of Tanzi (1989). Trade liberalization reduces government revenue—directly because of the fall in tariff revenue and indirectly because of the fall in revenue from the value-added tax and the labor income tax. The reduction in import protection results in a contraction in output of the importable sector and an increase in import volume, but total value-added tax revenue falls as output of the nontraded good declines and the exportable sector is exempt from the value-added tax. Since production of the importable good is labor intensive, the reduction in protection lowers real wages, and as a result, revenue from the taxation of labor income falls. The only positive effect on revenue comes from taxation of profits in the petroleum sector. As explained earlier, the reduction in the import tariff reduces P_N, so the relative price of the exportable to the nontraded good (P_X/P_N) rises.[19] Since the reduction in the import tariff induces a real exchange rate depreciation, exports expand and revenue generated from taxation of profits in the exportable sector increases. Nominal government expenditure falls somewhat, due to the reduction in the price of the nontraded good, but the loss in revenue exceeds the reduction in expenditure, so the budget deficit increases as a result of trade reform.

As noted by Blejer and Cheasty (1988), the effect of trade liberaliza-

[18] If the price of the nontraded good is inflexible, then trade liberalization is likely to result in unemployment as import-competing sectors contract.

[19] See Jones (1974) and Dornbusch (1974) for a further discussion of this result.

tion on the fiscal position of the government depends on many factors, including the price elasticity of demand for imports. If the demand for imports is price elastic, a reduction in protection would increase import tax revenue, ceteris paribus. But as there are many other factors to consider, it is necessary to determine the effect of trade liberalization using a fully specified general equilibrium model that captures important interactions in the economy, especially the cross-price effects that arise from changes in the price of the nontraded good on the demand for imports. This is one aspect of the issue that is demonstrated by the results in Table 2. When the price of the nontraded good is flexible, the reduction in total tariff revenue is greater than when P_N is fixed. This result occurs because trade liberalization reduces the price of the nontraded good (a real exchange rate depreciation), which reduces the demand for imports, since imports and the nontraded good are substitutes in demand.

As part of the trade liberalization experiments, the model was used to explore the public finance aspects of trade reform. In these experiments, the question is: how must other taxes be changed as a result of trade liberalization in order to hold the fiscal deficit fixed in real terms? Two other types of taxes are considered as replacement taxes: a change in the value-added tax rate and the introduction of a tax on the production of the exportable good. As is well known from the theory of public finance, a lump-sum tax has no distortionary cost. However, the analysis in this paper assumes that it is not possible to administer lump-sum taxes. Therefore, the choice for a replacement tax is between two distorting taxes. Each of these two alternatives represents a differential incidence experiment, as used in Ballard (1990), Shoven and Whalley (1977), and applied to the case of petroleum taxation in the United States by de Melo, Stanton, and Tarr (1989) and import tariffs in the United States by Rousslang and Tokarick (1995), where a tax is changed in order to keep the real budget position of the government constant in response to a policy change. The efficiency effects from these experiments are presented in Table 3.

As indicated in Table 2, trade liberalization worsens the government's fiscal position. If the revenue lost from trade liberalization is replaced by increasing the value-added tax rate, so as to keep the deficit of the central government constant in real terms, there would be a welfare gain of TT$346.5 million, which is less than the welfare gain from trade liberalization alone. This result occurs because an increase in the value-added tax rate intensifies the distortion in consumption of the importable and the nontraded good. The introduction of a tax on the production of the exportable good, at a rate of 32.6 percent, would replace the revenue lost from trade liberalization; however, a welfare gain of only TT$162.7 mil-

Table 3. *Efficiency Effects of Alternative Tax Policies Designed to Replace the Revenue Lost from Trade Liberalization*

(Millions of 1991 TT dollars unless otherwise noted)

	Trade liberalization	Replace revenue with change in:	
		VAT rate	Production tax
Tax rates (in percent)			
Value-added tax	5.7	10.5	5.7
Production tax	0.0	0.0	32.6
Percentage change in real wage	−2.5	−6.4	−9.8
Export volume	7,478.1	7,455.2	6,937.7
Import volume			
Final goods	2,012.4	1,986.3	1,461.8
Intermediate goods	3,832.0	3,835.2	3,842.2
Equivalent variation[a]	353.1	346.5	162.7
Real exchange rate index[b]			
(percentage change)	24.8	20.3	38.5

[a] The equivalent variation is computed by: $EV = E(P^0, U^1) - E(P^0, U^0)$, where $E(P, U)$ is the expenditure function; U^0 is the initial level of utility; U^1 is the new level of utility; P^0 is the vector of initial prices; and P^1 is the vector of prices after the policy change.

[b] The real exchange rate index is computed by dividing a weighted average of traded goods prices (inclusive of tariffs) by the price of nontraded goods. A positive value indicates a real depreciation. The formula for the real exchange rate is

$$RER = \frac{(0.09PW_M(1 + t_M) + 0.57PW_X + 0.34PWI)}{P_N}.$$

lion would result. The tax on the production of the exportable good reduces the volume of exports; thus, the effects of this tax are similar to the effects of a trade restriction, such as an import tariff. The reduction in the volume of exports leads to a corresponding reduction in the volume of imports, which lowers welfare, because consumption of the imported good is already distorted by both the import tariff and the value-added tax.

When the revenue lost from trade liberalization is replaced by either an increase in the value-added tax rate or a tax on the production of the exportable good, the economy experiences a welfare gain. The results of these experiments show that either a value-added tax or a tax on the production of the exportable good is a more efficient means of raising revenue than is an import tariff. This is so because a reduction in the import tariff combined with an increase in the value-added tax rate or a tax on the production of the exportable good that leaves the real govern-

ment deficit unchanged generates a welfare gain. Comparing the two types of replacement taxes (an increase in the value-added tax rate and a tax on the production of the exportable good), an increase in the value-added tax rate is a more efficient means of replacing the revenue lost from trade liberalization.

Results of Experiment 2: Terms-of-Trade Deterioration

Given the economy's dependence on trade, especially exports of petroleum, changes in the terms of trade have profound effects on the behavior of exports and the fiscal position of the government. This experiment examines the effect of a 5 percent deterioration in the terms of trade on the overall performance of the economy, concentrating on the trade and fiscal implications.[20]

Given the choice of the world price of imports as the numeraire, the deterioration in the terms of trade takes the form of a reduction in the world price of exportables, PW_X. This deterioration induces a contraction of the exportable sector, so output and employment both fall. Some of the labor released by the exportable sector is absorbed by the importable sector, so production of the importable good rises. This increase in the production of the importable good, coupled with a decrease in private demand, results in a reduction in import volume. The lower price of the nontraded good and the lower price of the exportable reinforce the reduction in private demand for the importable good and the corresponding fall in import volume. The contraction of the exportable sector also exerts downward pressure on the wage, which contributes further to the increase in output of the importable good, as production of the importable is labor intensive.

Of greater quantitative importance is the income effect of the terms-of-trade deterioration. As Table 1 shows, the percentage changes in the quantities demanded of both the importable and nontraded good with respect to a change in the price of the exportable are quite small, because the consumption share of petroleum is very small. The major effect of the reduction in the price of the exportable, however, comes through the income effect. The deterioration in the terms of trade reduces the value of exports and, with it, the value of production or GDP. This income effect serves to reduce the demand for all three goods, as they are all normal goods.

[20] A 5 percent deterioration is approximately the average deterioration over the period 1991–1993.

In this experiment, the relative price of the exportable to the importable is not constant, so it is not possible to form a composite good called a "traded good."[21] It is possible, however, to calculate an "exportables real exchange rate" (the relative price of the exportable to the nontraded good) and an "importables real exchange rate" (the relative price of the importable to the nontraded good). The reduction in the price of the exportable reduces the demand for the nontraded good (the substitution effect) and the negative income effect of the terms-of-trade deterioration reinforces this substitution effect. As a result, the deterioration in the terms of trade causes the price of the nontraded good to fall, but the exportables real exchange rate remains virtually unchanged as the reduction in the price of the nontraded good is roughly equal to the reduction in the price of the exportable. The terms-of-trade deterioration does result in a depreciation of the importables real exchange rate; this result is consistent with the theoretical findings of Edwards and van Wijnbergen (1987), Neary (1988), and Khan and Ostry (1991). In addition, as Edwards and van Wijnbergen point out, this possibility becomes more likely the more distorted the economy is to start with. In the case of Trinidad and Tobago, the economy is subject to many distortions, with the high level of nominal protection applied to imports representing a major bias against exports.

The deterioration in the terms of trade worsens the overall deficit of the government. This result occurs mainly because the terms-of-trade deterioration reduces tax revenue, principally oil tax revenue, since exports fall. Furthermore, the large reduction in imports results in a sharp fall in tariff revenue. Taken together, these two revenue sources account for the major share of the fall in tax revenue. The results from this experiment are presented in the second column of Table 4.

Results of Experiment 3: Terms-of-Trade Deterioration and Trade Liberalization

In this experiment, the model quantifies the effects of the program of trade reform as a policy response to the deterioration in the terms of trade. The results from this experiment are presented in the third column of Table 4.

As a policy response, trade liberalization mitigates many of the detrimental effects of the terms-of-trade deterioration alone. Compared with

[21] See Edwards (1989) for a discussion of this point.

Table 4. *Effects of a 5 Percent Terms-of-Trade Deterioration With and Without Trade Reform*

(Millions of 1991 TT dollars unless otherwise noted)

	Base case	Without reform	With trade reform
Real output			
Importables	2,130.2	2,225.9	1,628.5
Exportables	8,607.7	8,575.0	9,171.8
Nontraded	13,568.2	13,494.2	13,491.9
Government revenue	6,673.4	6,131.5	5,914.1
Oil tax	2,504.9	2,323.6	2,614.7
Tariff			
Final goods	544.8	335.7	168.4
Intermediate goods	—	—	193.9
VAT	1,051.7	978.4	772.8
Labor income tax	1,474.0	1,395.8	1,066.3
Other	1,098.0	1,098.0	1,098.0
Government expenditure	6,761.1	6,742.7	6,674.2
Government balance	−87.7	−611.2	−760.1
Export volume	6,702.7	6,682.3	7,473.8
Import volume			
Final goods	1,033.8	636.9	1,588.6
Intermediate goods	4,035.2	4,411.7	4,251.5
Trade balance	1,633.7	1,633.7	1,633.7
Percentage change in real wage	...	−1.2	−4.1
Equivalent variation[a]	...	−583.6	−229.4
(as percent of base-year GDP)	...	−2.5	−1.0
Relative prices (ratio)			
Exportables real exchange rate (P_X/P_N)	1.00	1.01	1.29
Importables real exchange rate (P_M/P_N)	1.53	1.62	1.50

[a]The equivalent variation is computed by: $EV = E(P^0, U^1) - E(P^0, U^0)$, where $E(P, U)$ is the expenditure function; U^0 is the initial level of utility; U^1 is the new level of utility; P^0 is the vector of initial prices; and P^1 is the vector of prices after the policy change.

experiment 2, trade reform provides a major impetus toward export expansion, as it offsets the negative effects of the terms-of-trade deterioration on exports and the reduction in consumer welfare is mitigated. Trade reform induces a major real devaluation—a reduction in the rela-

tive price of the nontraded good to the price of the exportable—which provides an incentive for export expansion. Both the importable and the nontraded sector contract to free inputs (labor) to the exportable sector. Thus, the flexibility of the real exchange rate—the price of the nontraded good—is very important in facilitating the adjustment of the economy to the new set of international prices.

When trade reform is superimposed on the terms-of-trade deterioration, the fiscal position of the central government worsens, over and above the increase in the fiscal deficit from the terms-of-trade deterioration alone. Trade reform reduces value added in the importable and nontraded sectors, as well as wages, so revenue from value-added taxes and taxes on labor income is reduced substantially. Although trade reform results in an expansion of exports and an increase in revenue from the taxation of profits on petroleum, the reduction in value-added tax revenue and labor income tax revenue is much greater, so total revenue falls. Nominal government expenditure falls somewhat, but by less than the fall in revenue, so the deficit increases. Thus, while trade reform ameliorates many of the adverse effects of the terms-of-trade deterioration, such as the effect on exports, it worsens the budget deficit of the government.

Results of Experiment 4: Public Finance Aspects of a Terms-of-Trade Shock

As shown from the results of experiment 2, a terms-of-trade deterioration worsens the budget deficit of the central government. In this experiment, the model is used to investigate the following issue: suppose the government wants to ameliorate the increase in the budget deficit from the terms-of-trade deterioration. What is the "best" means of reducing the budget deficit through a manipulation of tax policy? In this context, the term "best" refers to the most efficient means of reducing the deficit, that is, the tax policy that has the lowest deadweight loss per dollar of revenue raised. This experiment repeats the terms-of-trade deterioration of experiment 2 and considers two ways to hold the real budget deficit constant: a change in the value-added tax rate, and a combination of an increase in the value-added tax rate and the introduction of a tax on the production of the exportable good. In the first part, the value-added tax rate is altered and in the second, the value-added tax rate is increased to 8 percent along with the introduction of a tax on the production of the exportable good to keep the real deficit constant. The results from all three experiments are presented in Table 5.

Table 5. *Efficiency Effects of Alternative Tax Policies Designed to Replace the Revenue Lost from a Terms-of-Trade Shock*

(Millions of 1991 TT dollars unless otherwise noted)

		Replace revenue with change in:	
	Terms-of-trade shock	VAT rate	Production tax and VAT rate
Tax rates (in percent)			
Value-added tax	5.7	9.3	8.0
Production tax	0.0	0.0	19.9
Percentage change in real wage	−1.2	−4.2	−7.0
Export volume	6,682.3	6,662.2	6,277.7
Import volume			
Final goods	636.9	614.6	257.9
Intermediate goods	4,411.7	4,413.9	4,386.1
Real output			
Importables	2,225.9	2,230.2	2,379.1
Exportables	8,575.0	8,581.1	8,143.7
Nontraded	13,494.2	13,484.6	13,641.2
Equivalent variation[a]	−583.6	−598.5	−844.5

[a]The equivalent variation is computed by: $EV = E(P^0, U^1) - E(P^1, U^0)$, where $E(P, U)$ is the expenditure function; U^0 is the initial level of utility; U^1 is the new level of utility; and P^0 is the vector of initial prices.

Change in the Value-Added Tax Rate

As noted in Table 5, the value-added tax rate must rise from 5.7 percent to 9.3 percent in order to leave the real budget deficit unchanged. Also, the reduction in welfare from a terms-of-trade deterioration and an increase in the value-added tax rate is only slightly larger than the reduction in welfare that occurs from just the deterioration in the terms of trade. The increase in the value-added tax rate discourages the consumption of imports, and this acts to lower welfare since consumption of the importable good is already distorted by the import tariff.

Increase in the Value-Added Tax Combined with a Tax on the Production of the Exportable Good

As shown in Table 5, the value-added tax rate is increased to 8 percent and the tax on production of the exportable good must rise to 19.9 percent

in order to keep the real government deficit unchanged. The combination of these two tax increases results in a larger welfare loss compared to the welfare loss from just an increase in the value-added tax rate. The increase in the value-added tax rate intensifies the distortion in consumption of the importable and the nontraded good. Furthermore, the introduction of a tax on the production of the exportable good is an additional source of welfare loss as this tax acts to reduce the volume of exports beyond the reduction that occurs as a result of the terms-of-trade deterioration. The reduction in the volume of exports leads to a reduction in import volume, which lowers tariff revenue and leads to a greater welfare loss as the consumption of imports is already subject to a tariff. Thus, of these two alternative tax policies designed to reduce the budget deficit from a terms-of-trade deterioration, an increase in the value-added tax rate alone produces a smaller welfare loss, since the value-added tax applies to larger base than the tax on the production of the exportable good.

V. Conclusion

This paper used a general equilibrium model, applied to the economy of Trinidad and Tobago, to quantify the effects of trade reform on the real exchange rate, exports, imports, and the fiscal position of the government. The effects of trade reform on overall fiscal performance are of particular importance as there are clear limits on the government's ability to borrow.

A policy of trade reform by itself raises economic welfare in the aggregate, but the real wage falls in the case in which P_N is flexible. In theory, it is possible to design redistribution schemes so that those injured by trade reform could be fully compensated. Trade reform increases the volume of exports and imports since the reform program induces a real exchange rate depreciation. Flexibility in the price of the nontraded good is important for the full effects to be realized, as it is the fall in P_N that provides the incentive for exports to expand. The results show that if P_N is rigid, then trade reform will produce, at most, a modest expansion in exports. These results also suggest the need for policymakers to pursue policies that promote price flexibility in conjunction with trade reform. In the case in which the price of the nontraded good is inflexible, a nominal exchange rate depreciation would help bring about the change in relative prices that would result from trade liberalization by increasing the prices of traded goods. Thus, a nominal exchange rate depreciation would be a useful complement to a policy of trade liberalization when the prices of home goods are inflexible.

The result that trade liberalization will induce a real exchange rate depreciation is especially important for providing guidance on policy for the economy of Trinidad and Tobago. In the early 1980s, increases in the international price of petroleum squeezed other tradable sectors, namely importables, as the economy began to suffer from the Dutch disease. The fall in output and employment in the importable sectors was a natural consequence of the expansion of the exportable sector, since the rise in the price of oil attracted resources away from the importable sector. Furthermore, the rise in the price of oil threatened the viability of import-competing sectors because of the real exchange rate appreciation induced by oil price rise. The newfound wealth from the rise in the price of petroleum also increased the price of home goods, further strengthening the real exchange rate appreciation and the reduction in the output of importables. In response, the Government expanded the number of imports on the "negative list" in an attempt to offset reductions in output and employment in the importable sectors and discourage consumption of imports. The result of this policy was to contribute to further appreciation of the real exchange rate and a greater reduction in exports of goods other than petroleum. As these experiments show, trade reform induces a real exchange rate depreciation and an expansion in export volume; conversely, a policy of protection induces a real exchange rate appreciation. Furthermore, trade reform acts to worsen the deficit of the central government. However, the results show that it is possible to offset the increase in the deficit with increases in other taxes and still generate an aggregate welfare gain.

In the case of an adverse terms-of-trade shock, trade liberalization helps to mitigate many of the detrimental effects of the shock. Trade liberalization offsets, to some degree, the reduction in the volume of exports and imports from a terms-of-trade deterioration, but it worsens the budget deficit of the central government. Of the two options explored to reduce the deficit of the central government from a terms-of-trade deterioration, an increase in the value-added tax rate produces a smaller welfare loss compared to a combined increase in the value-added tax rate and the introduction of a tax on the production of the exportable good. A consideration of the revenue impacts of external shocks is important because the government's recourse to additional borrowing is limited.

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Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Perspective

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This paper examines the long-run determinants of the real exchange rate from a stock-flow perspective. The empirical analysis estimates a long-run relationship between the real exchange rate, net foreign assets, and other factors affecting trade flows. Using postwar data for the United States and Japan, cointegration analysis supports the finding that the structural factors underlying each country's net trade and net foreign asset positions determine the long-run path for the real value of the dollar and the yen. The empirical analysis also provides estimates for the underlying stochastic trend in each real exchange rate series. [JEL F31, F41]

As a theory of exchange rate determination, the doctrine of purchasing power parity (PPP) posits an underlying tendency for movements in the nominal exchange rate to offset movements in the ratio of national price levels, assuring constancy of the real exchange rate.[1] Based on this static measure of equilibrium relative prices, deviations in the real exchange rate from its PPP benchmark can then be viewed as gains or losses in external competitiveness.

However, real exchange rate movements do *not* completely coincide

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[1] See Dornbusch (1987) for a survey on PPP. See Breuer (1994) for a recent survey on the empirical evidence. In keeping with this literature, the real exchange is defined here as the currency-adjusted ratio of national price levels.

with perceived changes in competitiveness, reflecting a basic flaw in the PPP approach. Instead, the likely effects of exchange rate changes on the trade balance are often difficult to predict without further information regarding the source of the shock. Moreover, it may be quite misleading to view the real exchange rate as an isolated measure of external competitiveness without further reference to developments within the overall macroeconomic environment.[2]

Like other relative prices, real exchange rates are affected by real disturbances. In turn, real exchange rate movements stemming from real shocks may often represent fundamental shifts in the relative prices compatible with international equilibrium. Hence, a more general view of real exchange rate determination than the one offered by PPP is needed. Specifically, a distinction needs to be made between relative-price movements that represent lasting changes in the level of competitiveness and short-term fluctuations that reflect transitory departures from a given PPP level. Consequently, whether the long-run real exchange rate actually remains constant over a given time horizon (and PPP obtains) depends upon the behavior of its underlying economic determinants.

Viewing PPP as a fixed steady-state condition rather than as a long-run equilibrium condition, this paper investigates the sources of trend variation in the real exchange rate. Focusing on the United States and Japan, the empirical analysis examines the long-run relationship between the real exchange rate and the fundamental determinants that underlie the trend decline in the real value of the dollar and the trend appreciation in the real yen over the postwar period.

In examining real exchange rate determination, this paper implements a version of the macroeconomic balance approach,[3] which broadly defines the sustainable real exchange rate as that value or path consistent with internal and external macroeconomic balance. Internal balance corresponds to output being at its potential level in conjunction with a nonaccelerating rate of inflation. External balance requires a balance of payments position in which any current account imbalance is financed by a sustainable rate of capital flows.

[2] In a normative context, this basic identification problem also arises. As a policy target, PPP exchange rate rules provide an anchor to minimize potential misalignments. However, efforts to stabilize an inappropriate target for the real exchange rate have sometimes lead to increased macroeconomic instability. See Aghevli, Khan, and Montiel (1991), Montiel and Ostry (1991), and Calvo, Reinhart, and Végh (1994).

[3] See IMF (1984), Edwards (1989), Williamson (1990), and Bayoumi and others (1994) for discussions regarding the macroeconomic or underlying balance approach.

Since capital flows are simply international transfers of financial claims, sustainability of the capital account in turn rests upon the desired *stock* of external assets and liabilities between nations.[4] Integrating stock variables and stock-equilibrium relationships directly into the analysis has the advantage that flow equilibrium must follow as a necessary condition. Hence, a sustainable real exchange rate within a stock-flow framework can in principle account for both internal and external macroeconomic (flow) balance.[5]

Determinants of the equilibrium real exchange rate also include factors that affect the net trading position of the home country in world markets, as well as the underlying propensity of the home country to be a net lender or borrower of capital. In other words, the interaction between the permanent structural components in both the current and capital account jointly determine the sustainable real exchange rate.

On the trade side, among the factors that primarily operate through the current account, "the productivity approach," based on the seminal work of Balassa (1964) and Samuelson (1964), has perhaps received the most attention.[6] Other structural determinants, such as the stance of trade policy, variations in the terms of trade,[7] and the composition of fiscal spending, may also have a long-run impact on relative prices. In a developing country context, Edwards (1989) presents an empirical analysis of exchange rate determination emphasizing these and other factors affecting international equilibrium.[8]

Using cointegration techniques, this paper examines empirically the long-run determinants of the real exchange rate for the United States and

[4] See Masson, Kremers, and Horne (1994) for an empirical analysis on the long-run determination of net foreign assets for the G-3 industrial countries.

[5] The well-known transfer problem provides a useful illustration. Consider a country that experiences a steady-state decline in its stock of net foreign assets. The expenditure-reducing impact of this redistribution of wealth on domestic spending predominantly affects demand for domestically produced goods. Hence, this international transfer of wealth must be accompanied by a real depreciation at home and expenditure-switching toward home goods to allow adjustment at full employment (internal balance) and an improved trade position to offset lower interest income from abroad (external balance).

[6] See, for example, Hsieh (1982), Marston (1987), De Gregorio, Giovannini, and Wolf (1994), and Asea and Mendoza (1994) and the references cited therein for empirical and theoretical background on the Balassa-Samuelson effect.

[7] See Ostry (1988), Edwards (1989), and Khan and Ostry (1991) for further discussion regarding the effects of tariff changes and terms-of-trade disturbances on the equilibrium real exchange rate.

[8] See also Ostry (1988). For industrial countries, several studies have used a simulations approach to calculate real exchange rate trajectories compatible with macroeconomic balance. See, for example, Williamson (1990) and Bayoumi and others (1994) and the references therein.

Japan over the postwar era. In particular, structural components in both the current and capital accounts—underlying each country's net trade and net foreign asset positions—are shown to influence the path of the long-run real exchange rate for each country. The empirical analysis also provides estimates for the sustainable real value of the dollar and the yen over the postwar period, conditional on the stock of net foreign assets and real factors affecting trade flows.

I. Illustrative Model

Consider a world economy consisting of two countries—designated as home and foreign—engaging in the trade of two distinct goods and one financial asset.[9] The home country produces and consumes a domestic good, and purchases the foreign good through trade with the rest of the world. With the price of the foreign good serving as the numeraire, variables are expressed in real terms (measured in units of the foreign good) unless specified otherwise, and output is taken to be fixed at its full employment level.

Assets pay a fixed real rate of return, r^*, and the net stock of real assets held by home country is denoted by f. By assumption, the large foreign country absorbs any excess spending or saving in the home country through a flow of securities without affecting its demand for the home good. From goods market equilibrium, the trade balance for the home country, which also equals the difference between the value of domestic output and domestic spending, depends on the relative price of home and foreign goods plus an exogenous shift parameter. Specifically, net exports nx for the home country can be written as

$$nx = -\gamma q + x; \gamma > 0, \tag{1}$$

where q is the (log) real exchange rate defined as the real price of the domestic good so that an increase denotes a real appreciation at home; and x represents the shift parameter incorporating exogenous factors that affect the relative demand and supply of domestic and foreign goods, and

[9]The model is a continuous-time version of Mussa (1984). The analysis assumes imperfect substitutability in goods but not assets. In the case of imperfect substitutability in assets, portfolio effects provide the channel linking asset stocks and the exchange rate. Changes in asset positions reflecting changes the relative supplies of domestic and foreign debt, require changes in either the relative yield (risk premium) or the relative valuation (real exchange rate) to restore portfolio balance.

thus the trading position of the home country.[10] Note that equation (1) embodies the traditional elasticities approach to the balance of payments, allowing the contemporaneous relative price of exports versus imports (abstracting from J-curve effects) to impact on the trade balance, where the parameter γ captures the familiar Marshall-Lerner condition.[11]

Abstracting from detailed aspects of the service account, the current account is defined simply by the net trade in goods plus the interest income received (or paid) on a country's net foreign asset (or debt) position: $ca = nx + r^*f$. The current account balance also equals the rate of accumulation of net foreign assets held domestically:[12]

$$\dot{f} = -\gamma q + x + r^*f, \tag{2}$$

where dot variables throughout denote time derivatives, i.e., $\dot{y} = dy/dt$. Hence, $\dot{f}$ in equation (2) represents the instantaneous change in the stock of net foreign assets held by the home country resulting from a given current account position.

Determining the equilibrium real exchange rate over the medium term revolves around the issue of sustainability. A sustainable balance of payments position is one that reflects a current account balance financed by a desired or sustainable rate of capital flows.[13] In turn, a sustainable capital account position is based on the underlying determinants of net foreign asset equilibrium. That desired rate of net foreign asset accumulation (or decumulation) which mirrors a desired amount of excess saving (or spending) is characterized by the following behavioral equation:

[10] See Ostry (1988), Edwards (1989), and Khan and Ostry (1991) for further discussion regarding the effects of tariff changes and terms-of-trade disturbances. Note that the theoretical analysis is restricted to factors determining the relative price of imports versus exports. However, the subsequent empirical analysis generalizes the measure of international relative prices to also take into account factors that affect the relative price of traded versus nontraded goods.

[11] Equivalently, equation (1) can be interpreted from the absorption approach. As in the transfer example, countries favor their own goods in consumption. Hence, an increase in domestic real absorption—relative to (fixed) output—must be accompanied by an increase in the relative price of domestic goods to ensure goods market equilibrium.

[12] Net foreign assets here refer to both private and official holdings. Note that the real analysis here applies to both fixed and floating nominal exchange rate regimes.

[13] In general, the underlying balance approach defines the equilibrium exchange rate as that value or trajectory consistent with *both* internal and external macroeconomic balance. Transitory or short-run fluctuations in income are omitted here but they could be added—see Mussa (1984). In that case, the equilibrium real exchange rate would explicitly require both full-employment output and balance of payments equilibrium.

$$\dot{f}^d = \delta(r - \rho) + \phi(f^d - f);\ \delta, \phi > 0, \tag{3}$$

where the desired rate of accumulation $\dot{f}^d$ is a function of the difference between the domestic real interest rate r and the domestic long-run rate ρ, and the difference between the target level f^d and the actual level of net foreign assets.[14] The target variable measures the stock of net foreign assets that domestic residents would prefer to hold if the short-run rate of interest equaled ρ. As a baseline case, the long-run real interest rate is assumed fixed equal to the world rate of interest ($\rho = r^*$).[15]

In addition, the prevailing domestic real rate of interest r, which influences desired consumption and saving decisions implicit in equation (3), reflects the ex ante rate of return on assets measured in terms of home consumption:

$$r = r^* - \alpha E_t[\dot{q}], \tag{4}$$

where α is the expenditure share of domestic goods in home consumption, and $E_t[.]$ is the rational expectations operator conditional on the information set at time t. Equation (4) can be interpreted generally as an arbitrage condition equating real rates of return across borders with international capital mobility. In this very simple model with only one financial asset, equation (4) is also simply the Fisher equation, where the real interest rate is equal to the nominal interest rate less the rate of (CPI) inflation (both measured in units of the foreign good).

A sustainable balance of payments position, associated with flow equilibrium over the medium term, is identified by the relation $\dot{f} = \dot{f}^d$. In conjunction with internal balance, this condition ensures that the corresponding real exchange rate represents a sustainable equilibrium value or path consistent with underlying macroeconomic balance. Using equations (2), (3), and (4), this relation can be written as:

$$-\gamma q + x + r^* f = -\alpha\delta E_t[\dot{q}] + \phi(f^d - f). \tag{5}$$

The balance of payments equilibrium condition in equation (5) requires that the net flow of goods and services be equal to the rate of desired excess spending over income (desired current account). Equivalently,

[14]The postulated equation for desired holdings of net external assets serves as a short cut. Including this target level pins down the steady-state level of net foreign assets, avoiding the indeterminacy feature associated with standard infinite horizon models with representative agents, where *any* distribution of wealth is self-replicating (i.e., multiple stationary states). See Giavazzi and Wyplosz (1984).

[15]Setting $\rho = r^*$ assures a stable level for the real exchange rate in steady state. Otherwise, there would exist a steady-state rate of real appreciation or depreciation equal to the long-run real interest rate gap in equation (4).

from a flow of funds perspective, this condition specifies that the actual rate of net foreign asset accumulation be consistent with the desired net flow of financial claims (desired capital account). Hence, based on equation (5), the current account position over the medium term is financed by a sustainable rate of international capital flows.

Equations (2) and (5) together form a system of simultaneous linear equations consisting of two endogenous state variables, f and q, and two exogenous or forcing variables, f^d and x. Conditional on initial and terminal conditions for f and q respectively to ensure an economically sensible, nonexplosive solution,[16] the fundamental solution for q, derived in the Appendix, is given by:

$$q(t) = \bar{q}(t) + \sigma[f(t) - \bar{f}(t)]; \sigma > 0, \tag{6}$$

$$\bar{q}(t) = \frac{r^*}{\gamma}\bar{f}(t) + \frac{1}{\gamma}\bar{x}(t), \tag{7}$$

$$\bar{f}(t) = \lambda\int_t^\infty e^{-\lambda(s-t)}E_t[f^d(s)]ds, \tag{8}$$

$$\bar{x}(t) = \lambda\int_t^\infty e^{-\lambda(s-t)}E_t[x(s)]ds. \tag{9}$$

In expressions (6)–(9), bars over variables indicate long-run (stock) equilibrium values, while other variables reflect current (flow) equilibrium values. The forward-looking nature of the solution depicted above incorporates the fact that anticipations of future economic conditions are important for current variables, and, thus, the exchange rate is affected by market expectations.[17]

From equation (8), equilibrium holdings of net foreign assets $\bar{f}(t)$ depend on the expected forward evolution in the target level of net foreign assets $\{f^d(t)\}_t^\infty$. Similarly, as seen from equation (9), the exogenous permanent component in net exports $\bar{x}(t)$ relies on the present discounted value of the expected path of future trade disturbances $\{x(t)\}_t^\infty$. Finally, the central result is seen by equation (7), defining the long-run equilibrium real exchange rate $\bar{q}(t)$ as a function of these under-

[16] See Appendix for details. For a general discussion of continuous-time systems see Buiter (1989). See Blanchard and Khan (1981) for discrete-time analysis.

[17] The forward-looking nature of the solution results from the fact that desired excess spending is affected by the *expected* rate of depreciation. An "asset price" interpretation for this condition treats the expectations term as the anticipated capital gains from holding the foreign asset. Alternatively, from an intertemporal viewpoint, the expected future real exchange rate (i.e., *intertemporal* relative prices) influences an agent's optimal consumption allocations that maximize lifetime utility. See Mussa (1984).

lying components in both the current account and the net foreign asset position.

The relationship between sustainable adjustment over the medium term and long-run equilibrium is captured by equation (6). The sustainable (saddle) path for the real exchange rate $q(t)$—associated with internal and external macroeconomic balance—differs from its long-run value $\bar{q}(t)$ until full stock equilibrium is attained.

In transition, the real exchange rate may move away from its long-run equilibrium value to assure a convergent path for net foreign assets toward its steady-state value. For example, a permanent increase in the target level of net foreign assets, which requires an eventual and lasting real appreciation, initially depreciates the real exchange rate in order to improve the trade balance and increase the current stock of net foreign assets toward its higher desired long-run level.[18]

Steady-state equilibrium, characterizing a stable level of net foreign assets or liabilities, implies: $\dot{f} = \dot{f}^d = 0$. With exogenous forcing variables being constant at their steady-state values ($f^d(t) = \bar{f}$, $x(t) = \bar{x}$), equilibrium in stationary state is summarized by the following set of conditions:

$$q(t) = \frac{r^*}{\gamma}\bar{f} + \frac{\bar{x}}{\gamma}; f(t) = \bar{f}; nx(t) = -r^*\bar{f}; ca(t) = 0.[19]$$

Note that only when the economy reaches steady state and fundamentals have settled down to their *stationary* values does PPP obtain in terms of constancy of the real exchange rate. Meanwhile, with long-run movements in the fundamentals, a clear distinction exists between equilibrium exchange rate movements associated with changing steady states (and changing saddle paths), and a constant PPP value associated with a given stationary state.

In steady state, the trade balance is determined solely by the equilibrium level of net foreign assets.[20] This result can be interpreted as a

[18] The two variables q and $\bar{f}$ initially move in *opposite* directions in this case as evident from equation (6) and from the equivalent solution for q shown in the Appendix.

[19] The analysis can also be revised to account for steady-state growth rather than a stationary level of income, in which case a nonzero current account can exist in steady state. In steady-state equilibrium (with a constant real exchange rate but income growth), the trade balance and current account as a share of GNP depend on the stable *ratio* of net foreign assets to income along the balanced growth path. Otherwise, the analysis is essentially the same as described in the text.

[20] The model characterizes two basic types of fundamental shocks: those that affect the short-run trade balance (flow shocks) and those that affect the long-run

"stock" version of the absorption approach. The desired net foreign asset position anchors the sustainable series of net saving flows ($Y - A$ or $S - I$ balances) and trade balances. In steady state, net exports attain a sufficient "primary" surplus (deficit) to offset interest obligations (receipts) on the stable level of external debt (assets). Consequently, those disturbances that impact on the current account over the short term without affecting net foreign assets in the long run, translate into changes in the real exchange rate, without affecting net exports, in steady-state equilibrium.[21]

To summarize, determinants of the equilibrium real exchange rate include factors that affect both the net trading position of the home country in world markets and the underlying propensity of the home country to be a net lender or borrower of capital. In other words, the interaction between the permanent structural components in both the current account and the capital account jointly determine the sustainable real exchange rate.

On the trade side, determinants that operate primarily through the current account may include variables such as productivity growth differentials affecting the relative price of nontraded goods or commodity-price shocks affecting the terms of trade. On the finance side, fundamentals that essentially determine the economy's long-run net foreign asset position may include variables such as demographic factors, which affect net saving behavior through life-cycle effects, or the stock of government debt, which affects net national borrowing in the absence of Ricardian equivalence.[22]

II. Econometric Methodology

Of course, determining the relevant set of economic variables that underlie the sustainable real exchange rate remains an empirical issue, and devising an econometric framework based on the preceding discus-

net foreign asset position (stock disturbances), where only the latter type affect *both* q and nx in steady state. In practice, however, variables rarely fit neatly into either category and the empirics to follow do *not* require these types of shocks to be orthogonal. For the purposes of exposition, a fundamental variable is referred to as a determinant operating through the trade balance or net foreign assets depending on the primary channel through which that factor impacts on the real exchange rate.

[21] Following Ostry (1988), this result suggests that the direct effect of a permanent x shock on the trade balance is fully offset by the indirect effect through the change in the real exchange rate in the model.

[22] See Masson, Kremers, and Horne (1994).

sion becomes the focus here. The central considerations involve the identification and estimation of the long-run relationship between the real exchange rate and its fundamental determinants.

In that regard, cointegration analysis provides a natural conceptual framework for examining long-term comovements between a set of time-series variables. As a matter of definition, a set of N difference-stationary variables are said to be cointegrated if there exists at least one linear combination—i.e., cointegrating vector—of these variables that is stationary, defining their long-run relationship(s).[23]

Intuitively, cointegrated variables may drift apart temporarily, but must converge systematically over time. Hence, any model that imposes a deterministic long-run relationship between a set of integrated economic variables, while allowing those variables to deviate over the short term, will exhibit cointegration.

In the case of the real exchange rate, the presence of short-run speculative factors (reflecting asset market disturbances) and cyclical factors (given the sluggish adjustment of prices and wages) may cause the real exchange rate to deviate temporarily from its sustainable path, defined by the movement of its (nonstationary) fundamentals. Over time, the self-correcting mechanisms of an open economy ensure sustainable adjustment in the real exchange rate to its long-run value compatible with stock-flow equilibrium.[24]

Cointegration analysis generates empirical estimates for the long-run sustainable path of the real exchange rate, conditional on the time-series evolution of its fundamentals. Using the estimated cointegrating vector to identify the underlying stochastic trend, observed exchange rate movements can be decomposed into its transitory and permanent components (cycle and trend).

Annual data for the United States and Japan were obtained for the postwar period. For the real exchange rate, a CPI-based index of the real effective exchange rate (*REER*) was used.[25] Explanatory variables included stock data on net foreign assets as a share of GNP (*NFA*)[26] and

[23] Moreover, the number of independent cointegrating vectors r must be such that $0 < r < N$. If there were exactly N such linearly independent combinations, then the set of variables must all be stationary (i.e., integrated of order zero or I(0)). If no combinations exist ($r = 0$), the series are independent difference-stationary (i.e., integrated of order one or I(1)) variables.

[24] The basic long-run (cointegrating) relationship between the real exchange rate and its fundamental determinants based on the theoretical discussion is summarized by equation (7).

[25] All variables measured as indices are expressed in log-levels using 1985 as the base year (data source for *REER*: *International Financial Statistics*).

[26] Obtained from Masson, Kremers, and Horne (1994).

a terms of trade index (TOT)—constructed as the ratio of export unit value to import unit value.[27] As for productivity, two measures were implemented. First, following Kakkar and Ogaki (1993), a comparative index of the relative price of traded versus nontraded goods (TNT)—composed of the ratio of the domestic CPI to WPI relative to the corresponding (trade-weighted) index for the remaining G-7 countries (except Canada)—was constructed.[28] Second, a comparative index of labor productivity levels ($PROD$), constructed from rates of growth in real output per manhour in manufacturing at home versus the (trade-weighted) values for the rest of the G-7, was also used.[29]

In other contexts, the variable TNT, representing the relative price of nontraded goods, may actually serve as a measure of the real exchange rate. Of course, the two variables TNT and $REER$ should in principle be closely related, depending on the source of the shock. Specifically, shocks that irreversibly alter the relative price of tradables versus nontradables should be manifested in the stochastic trend in each series, reflecting the influence of the fundamentals common to both.[30] It is precisely for this reason that including TNT as a proxy for trends in sectoral productivity may help explain long-run trends in the real exchange rate.[31]

[27] Source: *International Financial Statistics*.

[28] Source: *International Financial Statistics*. Canada was excluded because of lack of data. Note that the wholesale price index predominantly measures traded goods prices, while the consumer price index has a significant component of services, which are generally not traded. Hence, the ratio of the two indices compared with each country's foreign counterpart serves as a proxy for the relative price structure in the United States and Japan compared with each country's major trading partners. Specifically, if $CPI = (P_t)^{\alpha}(P_n)^{1-\alpha}$ and $WPI = (P_t)^{\beta}(P_n)^{1-\beta}$, where $\beta > \alpha$, then the ratio will be an increasing function of the relative price of nontraded goods at home, $(P_n/P_t)^{\beta-\alpha}$.

[29] Source: Bureau of Labor Statistics. Note that *in levels*, output per manhour is not directly comparable across countries (the index level is arbitrary); however, trend comparisons can be made.

[30] To make explicit the relationship between $REER$ and TNT, note that the latter by definition can be expressed: $\ln(CPI/ECPI^*) - \ln(WPI/EWPI^*)$, where * indicates foreign variables and E is the nominal exchange rate. The first term in this expression is in fact $REER$ (ignoring coverage issues). If long-run PPP were to hold in tradables (i.e., $\ln(WPI/EWPI^*) \sim I(0)$), while the Balassa-Samuelson effect was the main source of secular trends in the real exchange rate, then $REER$ and TNT *alone* would cointegrate with a coefficient of unity. However, if permanent shocks to tradables cause $\ln(WPI/EWPI^*)$ to be nonstationary as well, then $REER$ and TNT will cointegrate only when some other measure(s) is included, capturing permanent movements in the relative price of traded goods. The model in the previous section highlights potential sources for these latter long-run movements.

[31] See De Gregorio, Giovannini, and Wolf (1994), and Micosi and Milesi-Ferreti (1994) for recent evidence on the relation between the relative price of nontraded goods and sector productivity differentials.

Under the assumption that (average) labor productivity in manufacturing reflects overall productivity in traded goods, the variable *PROD* provides a more direct measure of existing productivity differentials in tradables at home and abroad. Unfortunately, the equivalent measure for nontradables, which is inherently more difficult to define and measure, is not available. Since productivity in traded versus nontraded goods is the critical comparison, it should be noted that the measure *PROD* may be appropriate only under the further assumption that trend movements in relative productivity in services are insignificant among the major industrial countries.

III. Empirical Results

Cointegration estimation is conducted using the multivariate maximum likelihood estimation (MLE) technique proposed by Johansen (1988). The Johansen procedure provides test statistics for the number of cointegrating relationships that may exist, as well as empirical estimates for each of the cointegrating vectors.[32]

Before estimating the cointegration parameters, Augmented Dickey-Fuller (ADF) test statistics were calculated to indicate the order of integration in each of the univariate time series. The results of unit root tests—based on a unit-root null versus a trend-stationary alternative—are reported in Table 1. In every case, the ADF tests are consistent with each series being characterized as I(1) variables. Specifically, the ADF test fails to reject the presence of a unit root for each series in levels, but not in first differences.[33]

[32]The general empirical framework involves estimating a vector error correction model (VECM) of the form:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{j=1}^{k} \Gamma_j \Delta Y_{t-j} + \epsilon_t; \; \Pi = \alpha\beta',$$

where Y_t is an $n \times 1$ vector of I(1) variables. Under cointegration, the long-run impact matrix Π has nonzero rank $r < n$, equal to the number of linear combinations of the series in Y_t that are stationary. In that case, the singular matrix can be decomposed into two distinct $n \times r$ matrices α and β, where the latter is a matrix of cointegrating vectors such that $\beta' Y_t \sim I(0)$ and the former is a matrix of error-correction coefficients. See Campbell and Perron (1991) for a general discussion of the Johansen method.

[33]For the dollar real exchange rate, a case could be made for rejecting the null in favor of a trend-stationary alternative (p value near 0.10), given the low power of unit root tests. This result only highlights the near observational equivalence between trend-stationary and difference-stationary processes in finite samples. See Campbell and Perron (1991). However, the steady-state implications of a determimstic trend are quite unappealing.

Table 1. *Tests of Order of Integration*[a]

Variable	ADF(k) test statistic: United States (1950–90)	Japan (1951–90)
REER	−3.31 ($k = 1$)	−2.64
Δ*REER*	−3.85[b]	−4.11[c] ($k = 3$)
NFA	−1.44 ($k = 1$)	−2.46 ($k = 1$)
Δ*NFA*	−3.65[b]	−4.71[c]
TOT	−1.53	−2.68 ($k = 1$)
Δ*TOT*	−6.61[c]	−4.98[c]
TNT	−1.25	−2.77 ($k = 1$)
Δ*TNT*	−6.02[c]	−5.03[c] ($k = 1$)
PROD	−0.69	−0.92
Δ*PROD*	−5.63[c]	−5.84[c]

[a]The null hypothesis is a unit root versus a trend-stationary alternative. The ADF(k) test statistic for a variable x_t is given by the t-statistic on the estimated coefficient π_2 in the following auxiliary regression (including constant and trend):

$$\Delta x_t = \pi_0 + \pi_1 trend + \pi_2 x_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta x_{t-j},$$

where k is determined by the highest order lag for which the corresponding γ_j is significant. If the underlying data generating process is an AR(p), then $k = p - 1$. See Campbell and Perron (1991). Unless otherwise specified, $k = 0$ (Dickey-Fuller test).

[b]Indicates significance at 5 percent level.

[c]Indicates significance at 1 percent level; based on Mackinnon (1991) critical values.

United States

The test statistics for cointegration for the United States based on the Johansen procedure are reported in Table 2, using *TNT*. Tests for the number of cointegrating relationships in the data consist of the maximal eigenvalue and trace test statistics, where λMAX tests for at most r cointegrating vectors against a point alternative of exactly $r + 1$ cointegrating relationships, while TRACE tests for at most r cointegrating vectors against an alternative of at least $r + 1$ vectors.

The null hypothesis of no cointegration ($r = 0$) among the four time series in Table 2 is soundly rejected by both the TRACE and λMAX statistics.[34] Indeed, based on the test statistics, multiple cointegrating

[34]Replacing *TNT*, cointegration estimates using with *PROD* (not reported) also support a finding of cointegration. However, the latter measure consistently

Table 2. *Johansen Maximum Likelihood Tests and Parameter Estimates: United States (1950–90)*[a]

(Eigenvalues in descending order: 0.553, 0.391, 0.373, 0.190, 0.000)

Cointegration Likelihood Ratio Tests

Number of cointegrating vectors: null hypothesis	λMAX	Trace
$r = 0$	29.82[b]	73.30[c]
$r \leq 1$	18.35	43.47[c]
$r \leq 2$	17.30[b]	25.12[c]
$r \leq 3$	7.82	7.82

Parameter Estimates

(Corresponding maximal eigenvector)

	REER	*NFA*	*TOT*	*TNT*	Constant
Unrestricted	−39.38	41.56	6.03	35.20	−10.86
Normalized	−1.00	1.06	0.15	0.89	−0.28

Restricted Estimates

$REER_t = 1.54NFA_t + 0.91TNT_t - 0.30$;
(Exclusion on TOT, $\chi^2(1) = 1.95$)

$REER_t = 1.47NFA_t + TNT_t - 0.30$;
(Exclusion on TOT and homogeneity on TNT, $\chi^2(2) = 3.33$)

[a] Estimation involved a VAR with four lags and a restricted constant in the cointegrating vector. The Jacque-Bera test for normality and the Box-Pierce test against serial correlation (not reported) suggest that the selection of lag length is suitable. As a check for robustness, alternate lag length specifications were tested and do not affect the results.

[b] Indicates significance at 5 percent level.

[c] Indicates significance at 1 percent level; critical values based on Johansen and Juselius (1990).

relationships may possibly exist.[35] The cointegrating vector corresponding to the maximal eigenvalue (i.e., the dominant long-run relationship) is also reported in Table 2. The long-run coefficients have the correct

overstates the comparative decline in relative productivity for the United States in the first half of the sample and consequently yields non-normal errors in the estimation. Hence, subsequent analysis is conducted with *TNT* as the proxy for productivity in the case of the United States.

[35] The presence of multiple cointegrating vectors suggests the presence of multiple long-run economic relationships between the set of variables or some subsets thereof. For example, if the fundamentals influence one another in a long-run sense, these variables may cointegrate separately from the real exchange rate. Hypothesis testing for exclusion restrictions is conducted to examine this issue further.

Table 3. *Tests of Exclusion Restrictions: United States (1950–90)*[a]

Model: $\beta_1 REER + \beta_2 NFA + \beta_3 TOT + \beta_4 TNT + \mu \sim I(0)$

Single Exclusion Restrictions

Null hypothesis	LR(1) statistic assuming 1 cointegrating vector[b]	LR(2) statistic assuming 2 cointegrating vectors
$\beta_1 = 0$	9.96[c]	10.18[c]
$\beta_2 = 0$	7.81[c]	8.83[c]
$\beta_3 = 0$	1.95	2.13
$\beta_4 = 0$	8.78[c]	8.88[c]

Joint Exclusion Restrictions

Null hypothesis	LR(2) statistic assuming 1 cointegrating vector
$\beta_2 = \beta_3 = 0$	10.08[b]
$\beta_3 = \beta_4 = 0$	9.75[b]

[a] Also, exclusion restrictions for the constant μ are rejected at the 1 percent level of significance assuming either a single or multiple cointegrating vectors.

[b] The likelihood ratio test statistic LR(k) is distributed as $\chi^2(rk)$, where k is the number of restrictions and r is the number of cointegrating vectors.

[c] Indicates significance at 1 percent level.

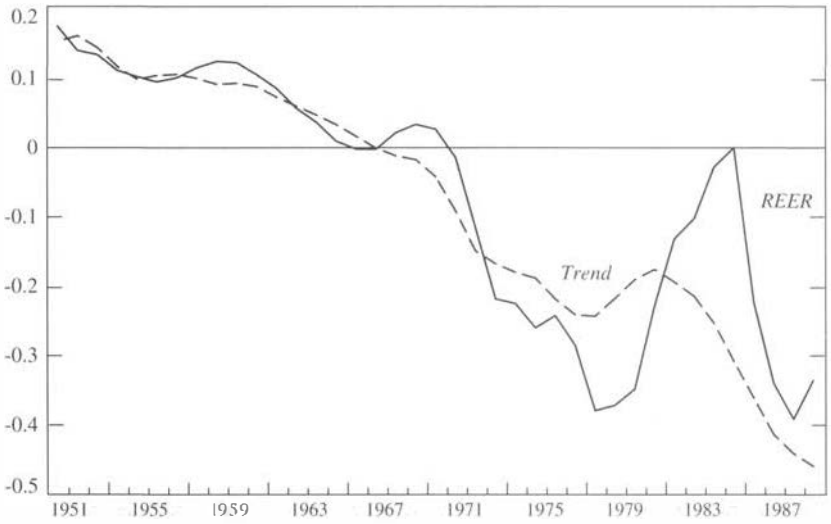
signs, and the point estimates on the normalized coefficients are of plausible magnitude.[36]

Tests of exclusion restrictions reported in Table 3 confirm that each variable enters the reported cointegrating vector and thus shares a deterministic long-run relationship with the real exchange rate, with the exception of the terms of trade measure *TOT*. Moreover, the test results of joint exclusion restrictions also shown in Table 3 support the finding that neither *NFA* nor *TNT alone* can explain permanent movements in *REER*.[37] Both productivity differentials and net wealth are found to be relevant in the long-run determination of the U.S. real exchange rate.

[36] Interpreting the cointegrating vector as the empirical analog to equation (7), the point estimate on the long-run coefficient of *NFA* suggests a real interest rate of about 5 percent, based on an empirical estimate of γ obtained from regressing the trade balance (as a share of GNP) on lagged cyclical fluctuations in the real exchange rate. Meanwhile, the estimated coefficient on *TNT* is close to unity, as expected.

[37] This second finding may have the following economic interpretation. Broadly speaking, permanent movements in *TNT* involve factors that affect the relative price of nontraded goods without necessarily affecting the relative price across traded goods. Meanwhile, equilibrium changes in *NFA* require movements in the relative price of imports versus exports without necessarily affecting the price of nontraded goods relative to traded goods (under the proviso that wealth effects are not biased in that regard).

Figure 1. *U.S. Real Exchange Rate: Actual and Trend Values*



Based on the estimated vectors of cointegration reported in Table 2, estimates for the trend component of dollar real exchange rate can be computed.[38] The underlying stochastic trend depicting the long-run path for the dollar real exchange rate is calculated based on the second set of restricted estimates reported in Table 2.

Figure 1 displays the dollar real exchange rate index (in logs, 1985 = 0) and its estimated trend component over the sample period. The vertical axis is measured in percentage terms. Based on the fitted trend, the variance ratio of permanent (trend) innovations to actual innovations in the real exchange rate is about 30 percent for the entire sample, and 20 percent for the subsample under floating exchange rates (1973–90). In

[38]The coefficients of cointegration are based on the long-run (I(1)) co-movements between the series over the sample period whereas the observed values of the variables comprise both long-run movements and short-run (I(0)) noise. Hence, to represent the common stochastic trend, filtered estimates of the fundamentals are subsequently used in the cointegrating relation rather than actual values. Specifically, the permanent component is smoothed using a centered three-year moving average of the fundamentals (the estimated coefficient of error correction for the dollar real exchange rate is about 0.8).

other words, about one fifth of the variability of observed real exchange rate changes can be attributed to permanent shocks and the variation of changes to the long-run real exchange rate.

The most salient feature of the time-series behavior of the U.S. real exchange rate over the postwar period is the overall steady decline in both its actual and sustainable values as evident in Figure 1. An explanation for the long-run real depreciation of the dollar becomes clear upon examining the path of its underlying fundamentals.

A well-known stylized fact of the postwar era is that industrial countries have experienced more rapid productivity growth and a tendency toward convergence in per capita income vis-à-vis the United States.[39] In turn, economic convergence among this group since World War II has had important consequences for the real value of the dollar.

With productivity gains accruing mainly in the traded goods sector, the relative price of traded versus nontraded goods declined more slowly in the United States (CPI/WPI ratio rose less quickly) than in the rest of the world. Consequently, the measure *TNT* exhibits a steady trend decline over the sample, only leveling off since the mid-1970s in conjunction with the productivity slowdown.[40] This downward secular trend, resulting from differential rates of biased productivity growth at home and abroad, appears to have been largely responsible for the declining real value of the dollar since the Second World War.

Meanwhile, net foreign assets, *NFA*, remained relatively stable over the entire sample until the 1980s. Since that time, however, the U.S. net foreign asset position has declined significantly, representing the transformation of the United States from the world's largest creditor to the world's largest debtor country.[41] The result has been a further decline in the sustainable value of the dollar real exchange rate toward the end of the sample period.

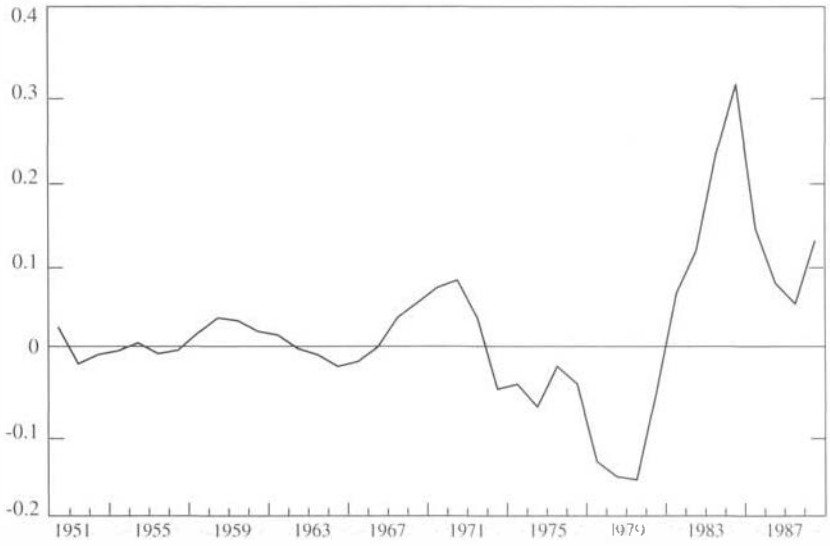
Based on estimates of the permanent component, cyclical fluctuations in the dollar real exchange rate—obtained as the difference between the actual and trend values—are shown in Figure 2. The vertical axis is once again measured in percentage terms. This (stationary) residual compo-

[39] The empirical literature on convergence documents the significant narrowing in the initial dispersion of income per capita and productivity measures across industrial countries over the postwar period until 1973. See Dowrick and Nguyen (1989) and the references therein for a review.

[40] Correspondingly, the evidence for catch-up and convergence has been much weaker since the productivity slowdown after 1973. See again Dowrick and Nguyen (1989). Perron (1990) estimates the slowdown in income growth using a nonlinear (breaking) trend for the G-7.

[41] Masson, Kremers, and Horne (1994) largely attribute the sustained decline in net foreign assets in the 1980s to the overall stance of U.S. fiscal policy and the associated increase in stock of public debt.

Figure 2. *U.S. Real Exchange Rate: Cyclical Component*



nent can be interpreted as transitory deviations from the long-run path, resulting from short-term cyclical and speculative factors.[42]

From Figure 2, note that the real dollar appears to have been above trend on more than one occasion during the Bretton Woods period.[43] This

[42]Long-run real exchange rate movements are positively related to movements in net foreign assets as seen by the positive long-run coefficient on *NFA*. However, over the cycle with macroeconomic imbalance and because of valuation effects, the real exchange rate and *NFA* can be shown to be negatively related in the short term:

$$\Delta NFA = \underset{(2.28)}{-0.10}\Delta\tilde{q} \underset{(1.99)}{- 0.09}\Delta\tilde{q}_{-1} \underset{(1.92)}{- 0.08}\Delta\tilde{q}_{-2} \underset{(4.51)}{- 0.23}\Delta\tilde{q}_{-4};$$

adj. $R^2 = 0.45$, s.e.e. $= 0.013$, DW $= 1.57$.
$LM[\chi^2(1)] = 1.98$, $LM[\chi^2(4)] = 4.56$,

where $\tilde{q}$ is the cyclical component shown in Figure 2 and absolute t-statistics are given in parentheses. Using actual *REER* instead in this regression would change the sign on some coefficients, significantly lower the R^2, and lead to serial correlation in the residuals due to misspecification (i.e., trend component in *REER* is dependent on *NFA*).

[43] A caveat is warranted on the interpretation of the cyclical component and the notion of disequilibrium. To the extent that the stochastic trend captures changing

result may not seem surprising considering the dollar's unique role as the reserve currency under the gold-exchange standard. Under the Bretton Woods system, U.S. payments deficits were essentially financed through an accumulation of dollar reserves abroad, as central banks maintained fixed parities vis-à-vis the dollar. Although, in principle, dollar reserves could have been converted into gold to offset the overall increase in world reserves, authorities generally accepted the increase in currency reserves as part of the mechanism providing international liquidity in a growing global economy.[44]

Figure 2 indicates that the largest divergence in the dollar real exchange rate relative to trend during the Bretton Woods period occurred toward the end of the regime. Substantiating this result, the last few years of the fixed exchange rate system witnessed a tremendous increase in outstanding dollar liabilities (up 250 percent between 1969–72), as the system ultimately collapsed. Although the observed value of the real exchange rate had actually shown a general decline until that time, the critical fact remains that the underlying trend value of the dollar fell even further.[45]

In comparing the behavior of transitory fluctuations across fixed and floating exchange rate regimes, a sharp difference is apparent in Figure 2. In particular, cyclical variation in the dollar real exchange rate has, not surprisingly, been much higher since 1973.[46] As for the more recent

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steady states, deviations between the actual and trend values do *not* necessarily represent (flow) disequilibria, as shown in the model (stock versus flow shocks). If trend movements reflect sustainable adjustment, deviations from trend do reflect transitory (flow) disequilibria. The estimation of the trend cannot further distinguish between these sources of long-run variation, without a priori information regarding equilibrium in the fundamentals. Alternatively, cyclical fluctuations can certainly be interpreted in a longer-run sense in terms of *stock* disequilibrium.

[44] Data from 1950 to 1972 confirm that U.S. payments deficits were largely accommodated by an increase in dollar reserve holdings abroad. The increase in dollar liabilities during that period was approximately $60 billion, while the decline in the gold stock was about $12 billion.

[45] This result provides empirical support for the view summarized by Krugman (1990):

> Arguably it was the secular decline in the equilibrium real dollar that really broke up Bretton Woods: the overvaluation of the dollar in 1971 owed little to faster U.S. inflation since 1960, and much to a decline in the real dollar compatible with international equilibrium. (p. 168)

[46] By construction, the cyclical component is stationary, and thus has a well-defined (time-invariant) second moment. Comparing variances before and after 1973 indicates that the transitory fluctuations (obtained from the fitted trend) in the dollar real exchange rate have been 16 times more variable under floating exchange rates.

behavior of the dollar, note that the period of massive nominal (and real) appreciation from 1980 to 1985 reflects a large divergence in the real dollar from its estimated long-run path.[47] Of course, ex post, this episode in fact proved to be unsustainable in the long run.[48]

Japan

The test statistics for cointegration in the case of Japan are reported in Table 4, using *PROD*. The null hypothesis of no cointegration among the four time series is again rejected by the TRACE statistic at the 1 percent level and by λMAX statistic at the 10 percent level of significance (critical value = 24.9), with the possibility of two cointegrating vectors. The vector corresponding to the maximal eigenvalue for Japan is reported in Table 4. Note that only the long-run coefficient on *NFA* has the correct sign, but the point estimate is quite large. However, the point estimates and coefficient signs appear sensitive to the choice of lag length of the VAR, and must be interpreted carefully.

Results of exclusion restrictions shown in Table 5 indicate that, in the presence of exactly one stationary linear combination, no single variable need enter the cointegrating vector, including *REER* itself. However, each variable must enter at least one of the vectors in the presence of two such long-run relationships. This finding suggests that different subsets of the real exchange rate and the explanatory variables are probably cointegrated. Based on tests of joint exclusion reported in Table 5, only productivity and the real exchange rate cointegrate alone, with the restricted estimates reported in Table 4.[49]

Cointegration estimates using *TNT* instead of *PROD* in the case of

[47] Reiterating an earlier caveat: the estimated cyclical component for the period from 1980–85 need *not* reflect completely a divergence from a value compatible with flow equilibrium. To the extent that the desired U.S. net foreign asset position also declined around that time, real exchange rate *overshooting* would in part be a necessary element of the adjustment process; a stronger currency is needed initially to induce a sufficient current account deficit to ensure a convergent path in net external assets toward its new stock equilibrium value. See also the Appendix.

[48] Stein (1993) provides estimates of the medium-term dollar real exchange rate, which tracks its actual path much more closely. Not surprisingly, the empirical analysis there places much greater emphasis on flow measures than on stock variables.

[49] The estimated cointegrating vector excluding *PROD* retains a large coefficient on *NFA* and an opposite sign on the coefficient for *TOT*: $REER_t = 3.03NFA_t - 0.56TOT_t$. The large coefficient on net foreign assets reflects the fact that its upward trend has clearly been outpaced by the rate of real appreciation in the yen.

Table 4. *Johansen Maximum Likelihood Tests and Parameter Estimates: Japan (1951–90)*[a]

(Eigenvalues in descending order: 0.522, 0.490, 0.130, 0.096)

Cointegration Likelihood Ratio Tests

Number of cointegrating vectors: null hypothesis	λMAX	Trace
$r = 0$	26.62	59.50[c]
$r \leq 1$	24.26[b]	32.88[b]
$r \leq 2$	8.62	8.62
$r \leq 3$	3.61	3.61

Parameter Estimates

(Corresponding maximal eigenvector)

	REER	*NFA*	*TOT*	*PROD*
Unrestricted	12.95	−104.99	16.92	13.31
Normalized	−1.00	−8.11	1.31	1.03

Restricted Estimates

$REER_t = 0.66PROD_t$;
(Exclusion on *TOT* and *NFA*, $\chi^2(2) = 1.95$)

[a] Estimation involved a VAR with four lags and an unrestricted constant to allow for possible deterministic trends. The Jacque-Bera test for normality and the Box-Pierce test against serial correlation (not reported) suggest that the selection of lag length is suitable. Similar results obtain with *TNT* instead of *PROD*.

[b] Indicates significance at 5 percent level.

[c] Indicates significance at 1 percent level; critical values based on Johansen and Juselius (1990).

Japan (not reported) yield very similar results. With either measure of productivity, the results of various exclusion tests appear somewhat sensitive (unlike the case of the United States) to the selection of the lag length of the VAR. In particular, exclusions restrictions on *NFA* and *TOT* may or may not be rejected under different specifications.

However, the empirical results on the role of *PROD* (and *TNT*) are robust, consistently rejecting its exclusion from any long-run relationship with the real exchange rate for Japan, and yielding consistent parameter estimates in the restricted vector of cointegration. In combination with the results for the United States, the empirical findings thus lend strong support for the "productivity approach" as described in Hsieh (1982), Marston (1987), and others, recast here in a cointegration framework.[50]

[50] See also Kakkar and Ogaki (1993).

Table 5. *Tests of Exclusion Restrictions: Japan (1951–90)*
Model: $\beta_1 REER + \beta_2 NFA + \beta_3 TOT + \beta_4 PROD \sim I(0)$

Single Exclusion Restrictions

Null hypothesis	LR(1) statistic assuming 1 cointegrating vector	LR(2) statistic assuming 2 cointegrating vectors
$\beta_1 = 0$	1.89	21.07[a]
$\beta_2 = 0$	1.61	20.27[a]
$\beta_3 = 0$	1.76	19.39[a]
$\beta_4 = 0$	0.81	19.78[a]

Joint Exclusion Restrictions

Null hypothesis	LR(2) statistic assuming 1 cointegrating vector
$\beta_2 = \beta_3 = 0$	1.95
$\beta_3 = \beta_4 = 0$	10.29[a]
$\beta_2 = \beta_4 = 0$	15.57[a]

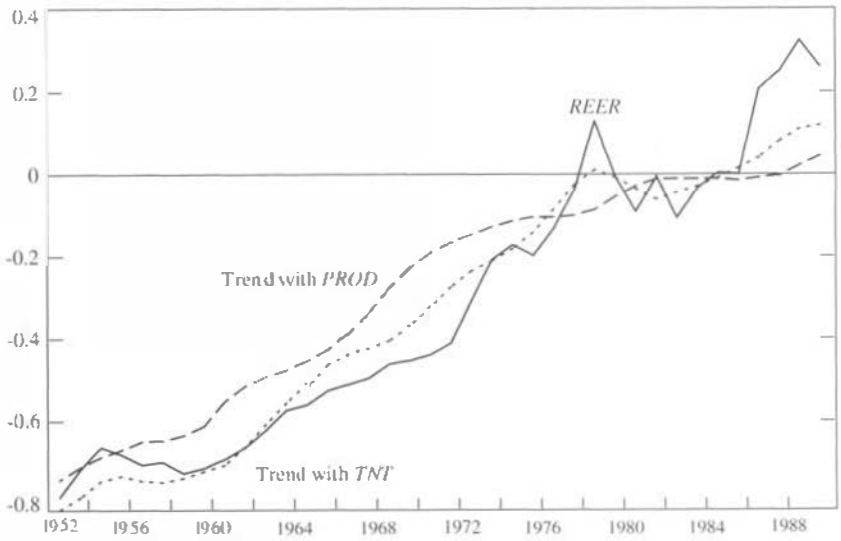
[a] Indicates significance at 1 percent level.

As a part of the convergence club, Japan like Western Europe has experienced a period of sustained productivity catch-up with the United States—the likely result of faster capital-deepening, technological spill-overs, or some combination thereof. Moreover, productivity gains in Japan have been more heavily concentrated in tradables than in other industrial countries, as evidenced by the manufacturing data. The comparatively faster rate of productivity growth in traded goods in Japan underlies the yen's real appreciation vis-à-vis not only the United States but other industrial countries as well.

Trend-cycle decompositions for the real value of the yen are shown in Figures 3 and 4. The (filtered) trend components in Figure 3 are based on the long-run relationship between *REER* and *PROD* in Table 4 and the corresponding estimates using *TNT*.[51] Both measures yield similar results, although the long-run estimates based on *PROD* generate a larger transitory component, probably as a result of omitting comparative productivity in nontradables. Based on the fitted trends, the variance ratios of innovations in the stochastic trend to innovations in the observed real exchange rate are 16 and 27 percent, using *PROD* and *TNT* respectively.

[51] The estimated cointegrating vector obtained by replacing *PROD* with *TNT* in the system is given by: $REER_t = 1.19 TNT_t$. The long-run coefficient on *TNT* is near unity as expected and smaller than the coefficient on *PROD* (due to faster trend growth in the latter series). Note that the above vector happened to be rejected by exclusion tests (for lag length = 4). However, that result is not robust to alternate lag-length specifications.

Figure 3. *Japanese Real Exchange Rate: Actual and Trend Values*



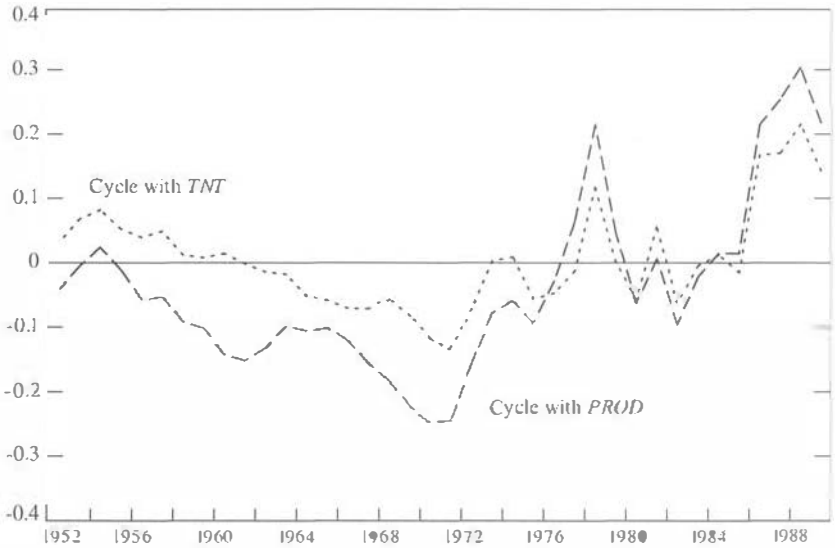
Both estimates of the cyclical component for Japan in Figure 4, indicate, interestingly, that the largest disparity in the actual rate relative to trend under Bretton Woods also occurred toward the end of the regime. Also of note, the quantitative estimates of misalignment for both the dollar and the yen real exchange rates during the breakup of Bretton Woods are broadly in line with the simulation results reported in Bayoumi and others (1994).

IV. Concluding Remarks

Viewing PPP as a fixed steady-state condition rather than as a long-run equilibrium condition, this paper has sought to explain long-run movements in the real exchange rate from a stock-flow perspective. Focusing on the United States and Japan, the empirical methods have applied recent cointegration techniques to examine the long-run determinants of the real exchange rate, in order to understand trend movements in the real value of the dollar and the yen over the postwar period.

For the United States, cointegration tests suggest that net foreign assets and productivity differentials share a long-run relationship with the real

Figure 4. *Japanese Real Exchange Rate: Cyclical Component*



exchange rate. This finding supports the proposition that the structural components of both the current and capital accounts—underlying a country's net trade and net foreign asset positions--jointly determine the long-run sustainable real exchange rate.

For Japan, the results are a bit less clear, except for the fact that productivity certainly matters in the long run. Cointegration tests for Japan suggest that various measures of productivity differentials share a long-run relationship with the real exchange rate. Historically, Japan has enjoyed tremendous productivity growth, particularly in manufacturing, along the path to economic convergence, thereby leaving room for little else to explain the extraordinary rate of real appreciation of the yen over the postwar period.

On the other side of convergence, the relative gains that industrial countries have made relative to the United States in terms of productivity and output explain much of the downward secular trend in the dollar real exchange rate since World War II. Thus, the empirical findings firmly support the view that sectoral productivity differentials explain a large portion of the trend variation in the real exchange rate for the United States and Japan.

APPENDIX

Solution Method

The system of equations defined by equations (2) and (5) can be written in matrix form as follows:

$$\begin{bmatrix} \dot{f}(t) \\ E_t\dot{q}(t) \end{bmatrix} = \mathbf{A}\begin{bmatrix} f(t) \\ q(t) \end{bmatrix} + \mathbf{B}\begin{bmatrix} x(t) \\ f^d(t) \end{bmatrix}, \tag{A1}$$

where **A** and **B** are conformably partitioned matrices of coefficients for the state and forcing variables, respectively. The solution method proceeds as follows. The matrix **A** can be diagonalized:

$$\mathbf{A} = \mathbf{V}^{-1}\mathbf{\Lambda}\mathbf{V};\ \mathbf{\Lambda} = \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix}, \tag{A2}$$

where $\mathbf{\Lambda}$ is a diagonal matrix of eigenvalues of **A**. It is straightforward to show that

$$\lambda = .5[r^* + \gamma/\alpha\delta \pm \sqrt{(r^* + \gamma/\alpha\delta)^2 + 4\gamma\phi/\alpha\delta}], \tag{A3}$$

where $\lambda_1 < 0$ and $\lambda_2 > 0$ (appropriate discount factor), so that the number of stable and unstable roots is equal to the number of predetermined and non-predetermined state variables, and the unstable root λ_2 corresponds to the state variable.[52] The matrix **V** is composed of linearly independent left eigenvectors of **A** and, along with the matrix of coefficients on forcing variables **B**, takes the general form

$$\mathbf{V} = \begin{bmatrix} V_{11} & V_{12} \\ V_{21} & V_{22} \end{bmatrix},\ \mathbf{B} = \begin{bmatrix} B_1 \\ B_2 \end{bmatrix}. \tag{A4}$$

The minimal state (fundamental) solution to this linear rational expectations system in equation (A1) for the nonpredetermined variable q has the following general and specific forms:

$$\begin{aligned} q(t) &= -V_{22}^{-1}V_{21}f(t) - V_{22}^{-1}\int_t^\infty e^{\lambda_2(s-t)}CE_tZ(s)\,ds \\ &= \sigma f(t) - \frac{\phi}{\alpha\delta}\int_t^\infty e^{-\lambda_2(s-t)}E_tf^d(s)\,ds + \frac{\lambda_2}{\gamma}\int_t^\infty e^{-\lambda_2(s-t)}E_tx(s)\,ds, \end{aligned} \tag{A5}$$

where **Z** is the vector of forcing variables in (A1) and where

$$c \equiv V_{21}B_1 + V_{22}B_2, \text{ and}$$

$$V_{21} = -\frac{\phi + r^*}{\alpha\delta(r^* - \lambda_2)},\ V_{22} = 1,\ B_1 = [1\ \ 0],\ B_2 = \left[-\frac{1}{\alpha\delta}\ \ \frac{\phi}{\alpha\delta}\right].$$

See Buiter (1989) for details.

[52] Hence, the steady state is indeed unique, avoiding indeterminacy problems (zero roots in the transition matrix) in the long-run determination of the real exchange rate like those discussed in Giavazzi and Wyplosz (1984).

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Relative Prices and Economic Adjustment in the United States and the European Union: A Real Story About EMU

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Structural vector autoregressions are used to analyze the relationship between real output and relative prices within the European Union and the United States. Relative price variability appears to be more important for adjustment within the European Union than in the United States, reflecting the lower integration of goods and factor markets. In the absence of higher market integration, the lower relative price variability implied by the introduction of a single currency in the European Union could well cause significant economic disruption. [JEL F15, F33, R11]

THE PROSPECT of European Economic and Monetary Union (EMU) has created interest in a host of issues associated with the operation of currency unions.[1] The most basic implication of adopting a common currency is that the participating countries are no longer able to vary their bilateral exchange rates. It is a widely held view that the loss of the ex-

*This paper has benefited from the comments of participants at a seminar at Georgetown University, particularly those of Matt Canzoneri and Susan Collins, as well those of Peter Clark, Chris Towe, and Mark Griffiths at the IMF. Tamim Bayoumi is an Economist in the Research Department. He is a graduate of Cambridge and Stanford Universities. Alun Thomas is an Economist in the Western Hemisphere Department. He is a graduate of MIT.

[1] here is a rapidly expanding literature on almost every aspect of EMU. For a survey see Eichengreen (1992).

change rate instrument will reduce the ability of economies to absorb disturbances. For example, the 1992 *Economic Report of the President* (of the United States) states: "A single currency would prevent exchange rate adjustments among European countries from absorbing external economic shocks or differences in domestic economic policies . . ." (p. 225).

Much of the academic analysis on EMU also assumes that the nominal exchange rate acts as a buffer in reducing disturbances; indeed, this is the basis of most of the theory of optimum currency areas. For example, work measuring the asymmetry of economic shocks in the European Union[2] assumes that a currency union is less efficient at absorbing asymmetric disturbances across different countries than a regime involving individual currencies, as does much of the literature on the fiscal implications of EMU (surveyed in Bean (1992)). Krugman (1991) also assumes that the exchange rate adjusts to moderate shocks when he argues that there will be a greater need for national exchange rates in a future, more integrated Europe because of the increased likelihood of asymmetric output imbalances due to regional specialization. In a slightly different vein, macroeconomic simulations of the impact of EMU (surveyed in Masson and Symansky (1993)) compare a regime in which each individual country has a fixed monetary target with a situation in which there is a single European currency and hence a single monetary target. In practice, this amounts to assuming that the nominal exchange rate operates as a buffer under the flexible exchange rate regime.

This paper looks at the empirical relationship between fluctuations in relative prices and real output using structural vector autoregressions, focusing on behavior across European Union (EU) countries and across regions of the United States.[3] Such a comparison of the behavior of EU countries, which have close economic ties but separate currencies, with regions within the United States, a currency union of roughly comparable economic magnitude, can be expected to shed light on how the existence of a currency union influences the response of the economy to underlying disturbances.

I. Theory

Movements in relative prices are one of the ways that economies buffer themselves against shocks to output. Consider the standard demand and

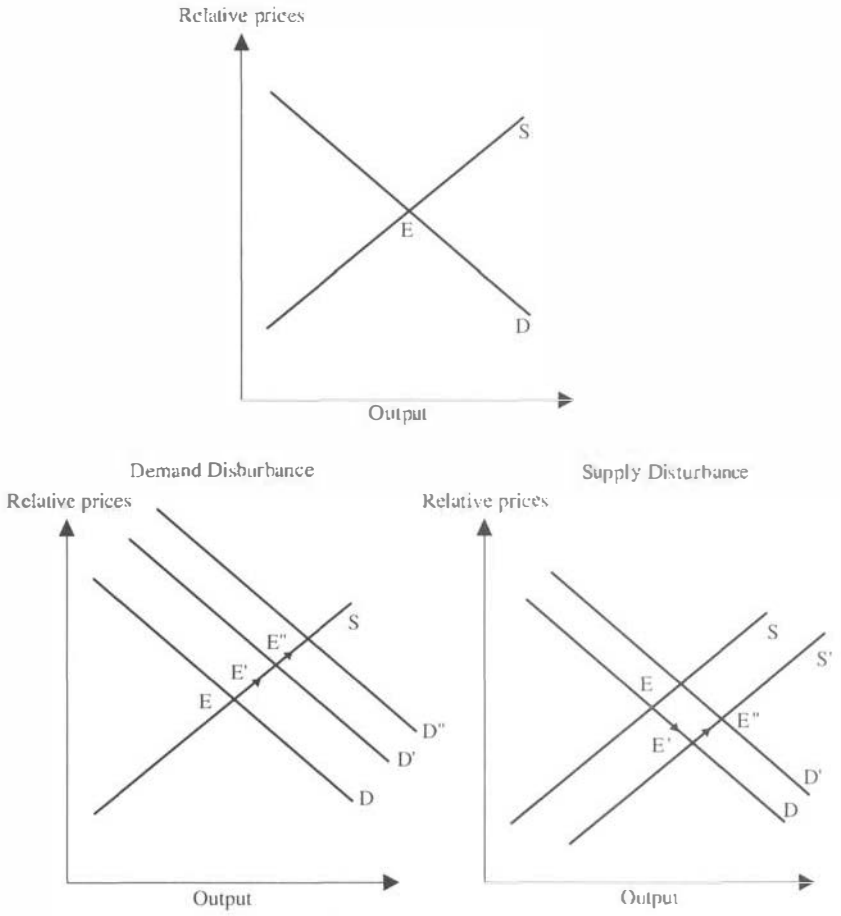
[2]Cohen and Wyplosz (1989), Weber (1990), and Bayoumi and Eichengreen (1993).

[3]We are unaware of any earlier empirical work of this type. Minford (1989) looks at this issue, but not from an empirical point of view.

supply model for a single industry shown in the top panel of Figure 1. A shock that moves the demand curve outward leads to a smaller rise in output than the overall shift in the curve because the relative price of output rises, reducing the full impact of the demand shock. In a similar manner, a positive supply shock leads to a fall in relative output prices, reducing the underlying output disturbance.

The same diagram can be used to analyze regional behavior. However, there is an important difference between the analysis of an industry and the analysis of a region. For a single industry, it is reasonable to assume that changes in the incomes of workers and owners in the industry have

Figure 1. *The Model*



negligible effects on the demand for the products from that industry, because they form such a small part of overall demand. In a region, on the other hand, regional incomes are an important determinant of the demand for regional goods (due, at least in part, to the existence of nontraded goods). This requires a more complex model than standard demand and supply analysis.

Appendix I contains a simple macroeconomic model of regional supply and demand. In the short run it is assumed that any changes in regional income accrue to owners of capital, whose consumption demand is highly diversified. Hence, the standard demand and supply analysis is adequate. Over time, however, much of the change in regional income is reflected in changes in labor income. This causes an endogenous change in the demand for home goods since workers are assumed to consume only these goods. Initial increases in regional output are therefore associated with a subsequent endogenous rise in demand for home goods, and falls in output, with a fall in demand for home goods.

Clearly, this is a very simple model. Not all short-run changes in income accrue to owners of capital, nor do workers spend all their money on local goods. At the same time, it does capture some stylized facts about the real world. Profits are indeed the most cyclically sensitive component of income, and their impact on the demand for local products is probably small.[4] More generally, the high short-term elasticities on activity in most estimated import equations also imply that external sources are an important provider of goods in response to short-term changes in income.

The bottom two panels of Figure 1 show the impact of these considerations on the original demand and supply analysis. The left-hand panel shows the response to a rise in the demand for regional products, such as an increase in the demand for automobiles in the United States (which would raise the demand for products from the Great Lakes region), or a fiscal expansion in an EU country. The initial rise in demand from D to D′ causes an increase in both regional output and the relative price of regional goods. The rise in local wage income that follows this increase in regional output causes a further expansion in the demand for regional goods, which moves the economy toward its long-run equilibrium at E″. Hence, the induced increase in demand moves both regional real output

[4] Profits can be retained, spent on investment goods (which have a large import component), or distributed to investors, who need not live in the region. None of these uses is likely to have a particularly large short-term impact on the relative demand for local products.

and the relative price of regional goods further away from their initial values.

The right-hand panel shows the effect of a positive supply shock, such as a technological breakthrough in the computer industry or a change in labor market regulations. The supply curve shifts rightward from S to S′, which results in a rise in real output and a fall in the relative price of regional goods, as shown by point E′. This increase in real output again implies an expansion in local incomes (measured in terms of local goods) and a subsequent expansion in the demand for regional goods. The induced shift in the demand curve (from D to D′) causes a further expansion in regional output. However, unlike the earlier example, where the relative price of regional goods continued to diverge from their original values, in this case the induced increase in demand causes the relative price of regional goods to move back toward its original value, as shown in the new long-term equilibrium E″.

While these dynamics complicate the adjustment path, they do not detract from the role of relative prices in reducing output fluctuations, particularly in the short run. The importance of relative prices in this process depends upon the integration of regional goods markets and factor markets. If regional goods and factor markets are highly integrated, so that the demand and supply curves are relatively flat, relative price changes in response to disturbances will be relatively small. Hence, relative prices could be expected to be a less important part of adjustment in the United States, with its highly integrated markets, than in the European Union, with its less integrated goods and factor markets.

If regions have the same currency, then relative price movements have to occur through inflation differentials. If they have different currencies, however, these relative price movements can also come about through changes in the exchange rate. Since exchange rates appear to be more flexible than domestic prices, this implies that relative price changes may be more difficult to achieve in a currency union.[5] Such slow adjustment can cause significant disruption to the local economy. Good examples would be the boom and bust in employment experienced by the Southwest region of the United States in the 1980s due to the rise and fall in oil prices; the difficulties experienced by (then) members of the Exchange Rate Mechanism (ERM) in 1992 and 1993 in the wake of German unification; and regional problems within European countries, such as the persistent differences in unemployment rates between the northern and southern regions of the United Kingdom and Italy. The remainder

[5]Mussa (1990) discusses the role of flexible nominal exchange rates in real exchange rate variability.

of this paper estimates the role of relative price movements (or, in other words, movements in real exchange rates) in the process of adjustment between members of the European Union, and compares it to the role of relative price movements in the United States, a smoothly functioning currency union.

II. Estimation Methodology

The model shown in Figure 1 is estimated using a structural vector autoregression (VAR) of the type proposed by Blanchard and Quah (1989), in which underlying disturbances are identified through their long-run responses to endogenous variables.[6] Specifically, a bivariate vector autoregression involving real output and the relative output prices is estimated, and the underlying supply disturbances are identified by assuming that they have only a temporary effect on relative output prices, while demand disturbances are allowed to have a permanent effect. Hence, the estimation assumes that the long-term equilibrium for a supply disturbance (point E″ in the bottom right-hand panel of Figure 1) involves the same relative price as the initial equilibrium. Details of the estimation procedure are given in Appendix II.

Clearly, identifying disturbances with only a temporary impact on the relative prices as supply disturbances and those with a permanent impact on relative prices as demand disturbances is a strong assumption. The underlying supply and demand framework only implies a tendency for relative prices to return to their initial level in response to a supply disturbance. However, as long as the long-term effect of a supply disturbance on relative prices is small in relation to the effect of a demand disturbance, the procedure will approximate the correct model.[7] There are at least two reasons for believing that this is indeed the case. First, as discussed earlier, the induced changes in demand caused by movements in local incomes will tend to exacerbate long-run relative price movements caused by demand disturbances while reducing those due to supply disturbances. Second, it seems reasonable to assume that goods markets are more highly integrated than factor markets. This implies that the underlying supply curve will be steeper than the demand curve, which in turn implies larger relative price movements in response to demand disturbances than to supply disturbances.[8]

[6] A VAR is a system of two or more variables in which each variable is related to lagged values of all of the variables in the system (Sims (1980)).

[7] This is proved in the technical appendix of Blanchard and Quah (1989).

[8] Some empirical evidence in support of this assumption can be found in Clarida

The advantage of using the structural vector autoregression approach is that it allows more structure to be put in the empirical analysis than would be possible from a more atheoretical examination of the data. In particular, as will be discussed in more detail below, it implies that most of the differences in macroeconomic adjustment between the United States and the European Union can be attributed to relatively intuitive differences in the slopes of the underlying curves and sizes of the underlying disturbances.

As a further check on the results, two "over-identifying" restrictions, which are implied by the underlying framework but are not imposed in the estimation, can also be used to test the plausibility of the results. The first is the sign of the relative price movements in response to each shock. The model implies that positive demand shocks should increase real output and raise the relative price of local output, while supply shocks that raise real output should lower the relative price of output. Second, as can be seen in Figure 1, the underlying supply curve can be identified both by the response to a demand disturbance and by the longer-term part of the response to a supply disturbance. These restrictions, which can be seen as additional tests of the reasonableness of the results, are broadly confirmed by the estimation.

III. Data

Annual data on real and nominal output in dollars were collected for 11 EU countries and 8 U.S. regions.[9] For the European Union, the data came from the *OECD Annual National Accounts*. Real dollar GDP was calculated using 1985 prices and exchange rates, while nominal dollar GDP used current prices and exchange rates. The EU sample period is 1961–89.[10] Regional real and nominal gross state product, the regional equivalent of GDP, were collected for the eight standard regions

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and Galí (1994), who analyze a three-variable VAR for Germany, Japan, Britain, and Canada, all relative to the United States. Using a slightly different approach from ours, they isolate aggregate demand, aggregate supply, and monetary shocks. They find that supply shocks explain only a small amount of the conditional variance of real exchange rate in these countries, and that the long-run real exchange rate responses to supply shocks are small.

[9]The 11 countries include every EU country except Luxembourg, which apart from being very small was also in a currency union with Belgium over the sample period.

[10]This period includes the collapse of the Bretton Woods exchange rate system in the early 1970s. Since Chow tests indicated no significant change in behavior in the early 1970s, the full data set was used to conserve degrees of freedom in the estimation.

of the United States, as defined by the Bureau of Economic Analysis, from 1963–89.[11]

Relative prices were calculated by taking the implicit output deflators for each EU country or U.S. region and dividing them by the corresponding deflator for the remainder of the European Union or United States (that is, the EU or U.S. aggregate less the country or region). Hence, they measure relative output prices within the area, the proper concept for a demand and supply analysis. Output growth was also measured relative to behavior in the rest of the European Union or United States. Therefore, the data represent *intra-area* movements in relative prices and output across U.S. regions and EU countries.[12] It is important to exclude the effects of the rest of the world from the analysis because, while U.S. regions have a fixed rate of exchange against each other, the United States as a whole has a variable exchange rate against the rest of the world. Similarly, EMU will fix only intra-EU rates of exchange, and not rates of exchange with the rest of the world.

Before considering the estimation results, it is useful to consider the characteristics of the raw data. Table 1 reports the standard deviation of the growth of real output and the change in the relative price of output (measured as the change in the logarithm of the underlying variables).[13] To give an idea of the impact of adjusting by the regional aggregate, the standard deviations for the unadjusted data are shown in parentheses.

For the European Union, the standard deviation of relative output growth varies considerably, from 0.010 to 0.027 (about 1.0 to 2.7 percent per annum since the data are in logarithms). The original members of the European Union (Belgium, France, Germany, Italy, and the Netherlands) all have lower variation in their output growth rates than those that joined later, with France having a particularly low value. The unadjusted data, shown in parentheses, generally show more variation than the adjusted data, indicating a common cycle. The results from the regional data for the United States are shown in the bottom part of Table 1. The variability of intra-U.S. output growth is generally smaller than the variability of intra-EU output, although the absolute values are similar. This suggests that fluctuations are more synchronized with aggregate behavior across the United States than across the European Union. However, this

[11] New England, the Mideast, Great Lakes, Southeast, the Plains, Southwest, Rocky Mountains, and Far West.

[12] As a result, external disturbances, such as the oil shocks of the 1970s, will only have an influence in so far as the individual regions or countries reacted in a different way from the region as a whole.

[13] Results for the period after the breakup of the Bretton Woods system are very similar to those for the whole period.

Table 1. *Growth of Output and Changes in the Relative Price of Output within the European Union (1973–89) and the United States (1966–89)*

	Standard deviation of growth of output	Standard deviation of change in relative GDP deflators
	Original EU members	
Belgium	0.013 (0.022)	0.036 (0.108)
France	0.010 (0.018)	0.040 (0.104)
Germany	0.013 (0.022)	0.045 (0.106)
Italy	0.019 (0.023)	0.033 (0.090)
Netherlands	0.013 (0.022)	0.034 (0.102)
	Later EU entrants	
Denmark	0.019 (0.025)	0.032 (0.100)
Greece	0.027 (0.035)	0.056 (0.077)
Ireland	0.026 (0.022)	0.038 (0.092)
Portugal	0.024 (0.034)	0.049 (0.090)
Spain	0.019 (0.026)	0.049 (0.110)
United Kingdom	0.019 (0.021)	0.072 (0.102)
	U.S. regions	
New England	0.018 (0.032)	0.006 (0.020)
Mideast	0.014 (0.025)	0.007 (0.020)
Great Lakes	0.019 (0.038)	0.006 (0.022)
Plains	0.012 (0.025)	0.012 (0.022)
Rocky Mountains	0.024 (0.024)	0.009 (0.026)
Southeast	0.008 (0.025)	0.005 (0.023)
Southwest	0.023 (0.023)	0.020 (0.038)
Far West	0.014 (0.024)	0.005 (0.019)

is not true for the Southwest and Rocky Mountain regions, whose output is heavily dependent on raw material production. In these regions, adjusting for aggregate U.S. activity has no impact on variability, indicating that growth is relatively uncorrelated with aggregate U.S. behavior.

The standard deviation of relative prices in the European Union varies from 0.032 in Denmark to 0.072 in the United Kingdom.[14] There is a clear split between the original members of the European Union plus Ireland and Denmark, which have relatively low standard deviations, and the higher variation experienced by the United Kingdom, Greece, Spain, and Portugal. Table 2 shows the contribution of variability in national price levels and variability in nominal exchange rates to overall relative

[14] In every case, the values in parentheses, which show relative price variability against the United States, indicate much higher variation, presumably reflecting movements in the nominal exchange rate of the dollar over the period.

Table 2. *Decomposition of Variance in Relative Prices*

	Standard deviation of change in relative prices	Standard deviation of change in national prices	Standard deviation of change in nominal exchange rates	Correlation between changes in national prices and nominal exchange rate
		Original EU members		
Belgium	0.043	0.022	0.032	0.24
France	0.037	0.013	0.039	−0.33
Germany	0.049	0.023	0.043	0.00
Italy	0.039	0.027	0.047	−0.56
Netherlands	0.038	0.019	0.028	0.26
		Later EU entrants		
Denmark	0.039	0.014	0.031	0.38
Greece	0.066	0.036	0.064	−0.20
Ireland	0.038	0.037	0.042	−0.55
Portugal	0.059	0.042	0.083	−0.74
Spain	0.056	0.032	0.065	−0.49
United Kingdom	0.086	0.045	0.075	−0.03

price variability for members of the European Union. The major difference between the original EU members, Ireland, and Denmark and the remaining countries is the lower level of nominal exchange rate variability in the first group (shown in the third column of figures), presumably reflecting the greater desire in these countries to stabilize intra-European exchange rates, as illustrated by their long-term membership in the ERM in the 1980s and the snake of the late 1970s.

Table 2 illustrates two other characteristics of intra-EU relative prices between 1963 and 1989. The first is the importance of nominal exchange rates in relative price movements. The standard deviation of the change in the nominal exchange rate is larger than that of relative national prices in every country except the Netherlands, and in most cases this difference is quite large. Another feature of the EU results is that the original EU members exhibit somewhat smaller variability of national prices than do newer entrants. Intra-U.S. relative price variability, reported in the bottom half of Table 1, is yet smaller.[15]

[15] Earlier work on real exchange rate variability within currency unions includes Poloz (1990) and Eichengreen (1990).

IV. Results

To identify supply and demand disturbances, structural vector autoregressions were estimated for each EU country and U.S. region by regressing the change in the logarithm of real output and of relative prices on the first and second lags of both series, and using the assumption that supply disturbances have no long-run impact on relative prices to identify demand and supply disturbances.[16] The number of lags in the vector autoregressions was set at two since the Schwarz-Bayes information criterion indicated an optimal lag length of one or two in each case.[17] The estimation period was 1963–89 for EU countries and 1965–89 for U.S. regions.

European Union and United States

Figure 2 shows impulse response functions for the 11 EU countries and 8 U.S. regions. Impulse response functions illustrate the impact on output and relative prices of a supply or demand disturbance equal to 1 standard deviation. Hence, the path shows the response of output and relative prices to a "normal" disturbance, and the size of the response is a measure of the importance of the particular disturbance. To aid comparison, the graphs for each response have the same scale.

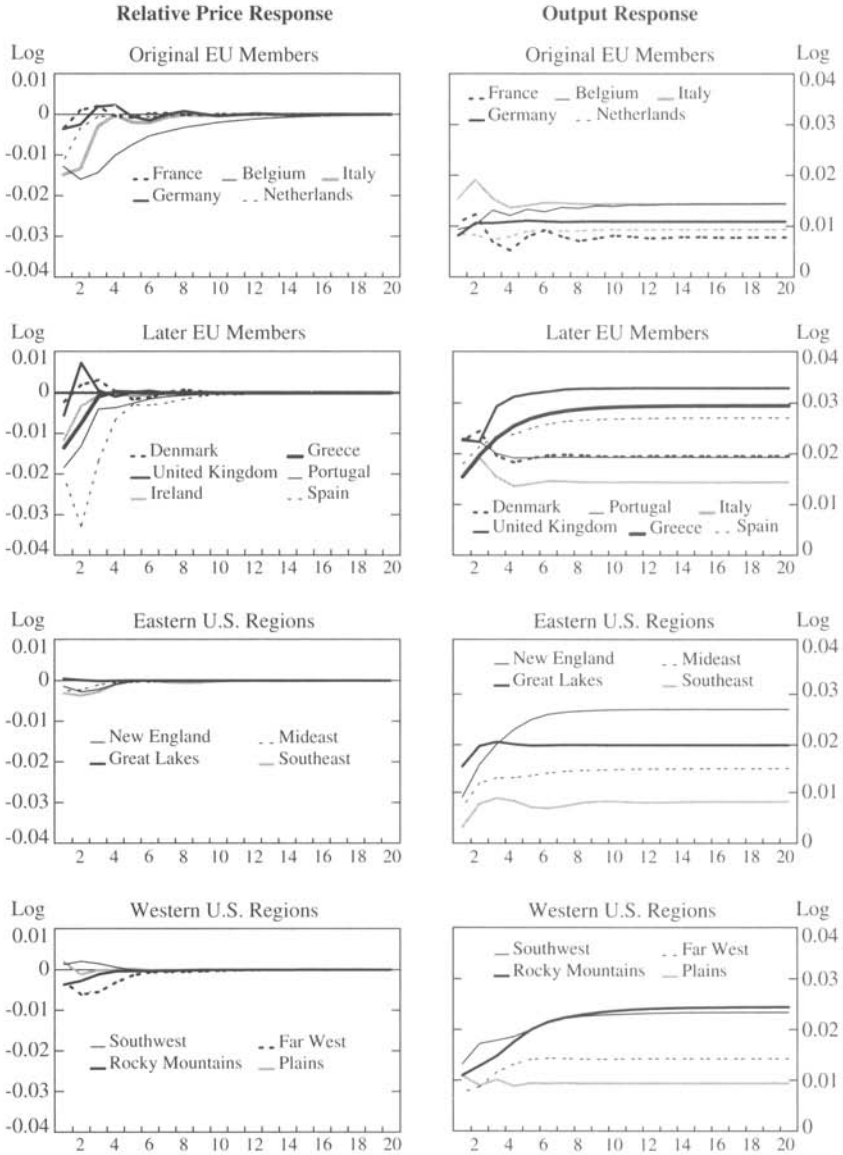
The response of relative prices to a supply disturbance, shown in Figure 2, illustrates the restriction imposed on the estimation procedure, namely, these disturbances have no long-run impact on relative prices. The responses of EU entrants are generally larger than those of the original EU members. Much more striking, however, are the much smaller relative price movements across U.S. regions. This is even true for the raw material producing regions (the Southwest and Rocky Mountains), which have the largest relative price responses of the U.S. regions.

Figure 2 also shows the response of output to supply shocks. The long-run response of output in the European Union is between 0.005 and 0.04 (since the data are in logarithms, this implies responses of between 0.5 and 4 percent), with the responses for the newer EU entrants being generally larger than those for the original members. The magnitude of the long-run responses of U.S. regions is similar to those of EU countries,

[16]For both data sets, Dickey-Fuller tests indicated that the logarithms of the level of both real output and relative prices were nonstationary, but that the first differences were generally stationary. Accordingly, all variables were transformed into first differences.

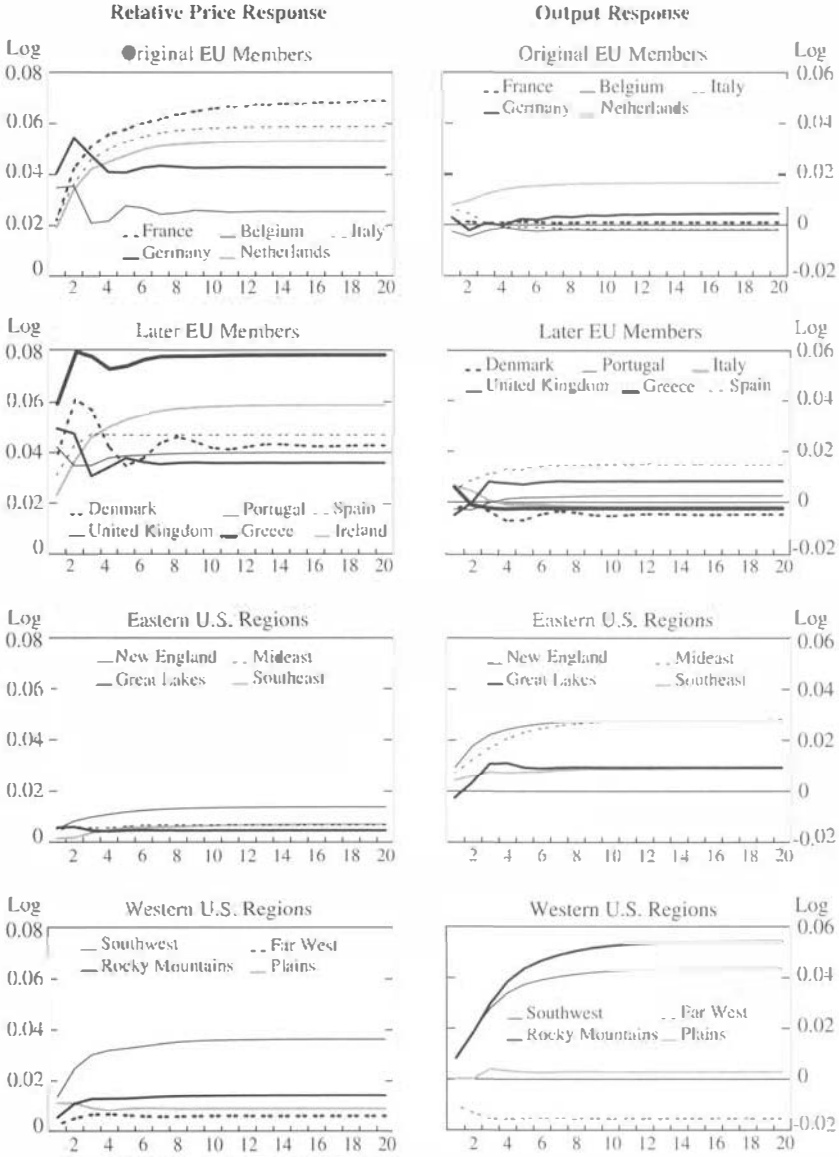
[17] A uniform lag of two was chosen in order to preserve symmetry across the estimation.

Figure 2. *Response to Supply Disturbance*



Note: The graphs show the response of output and relative prices to an average supply disturbance over time. Since the response are measured using logarithms, a change of 0.01 is approximately equal to 1 percent.

Figure 3. *Response to Demand Disturbance*



Note: The graphs show the response of output and relative prices to an average demand disturbance over time. Since the responses are measured using logarithms, a change of 0.01 is approximately equal to 1 percent.

although the speed of adjustment is slower. The two U.S. regions that are most specialized in raw material production, the Southwest and Rocky Mountains, again have relatively large responses.

The overidentifying restriction implied by the model is that the short-run effect on relative prices should be the opposite of that on real output. This response, which is not imposed on the estimation, is satisfied for all of the EU countries. The results for the U.S. regions are less uniform. While most regions show a fall in relative prices, there are three exceptions: the Plains, the Far West, and the Great Lakes. However, in all three cases the responses are small compared with those of the other U.S. regions. Overall, combining the results for the European Union and United States, the relative price response is correct in 16 of 19 cases.[18]

Impulse response functions for demand disturbances are shown in Figure 3. The EU countries show relative price responses of between 0.02 and 0.07 (between 2 and 7 percent), with no clear difference between the behavior of the original EU members and newer entrants, although the original members do show some evidence of slower adjustment. As in the case of the supply disturbances, there is a big difference between the relative price responses in the European Union and in the United States, with the U.S. responses being much smaller than the EU ones. Within the U.S. regions, the largest relative price responses are again associated with the regions that specialize in raw material production.

In contrast to the relative price responses, the output responses to demand disturbances in the European Union are generally small, particularly for the original EU members, while the responses for the U.S. regions are significantly larger. The overidentifying restriction of the model is that the output response should have the same sign as the relative price response. Of the 11 EU country estimates, 7 have the anticipated response, while 4 responses are perverse. However, as with the U.S. regional results for supply disturbances discussed above, these perverse responses are all relatively small. The responses of the U.S. regions to demand shocks conform to the predictions of the model rather more closely than those for the EU countries, with only one region (the Far West) having a perverse response. Aggregating over both the European Union and the United States, the responses conform to the predictions of the underlying framework in 14 out of 19 cases.[19]

Overall, the results paint a fairly consistent picture. The European

[18]The probability of getting 16 or more correct responses if the responses were random is $1160/2^{19}$, or about 0.2 percent. Hence, there is considerable evidence that the overidentifying restriction is satisfied.

[19]The probability of this occurring randomly is $16664/2^{19}$, or 3.2 percent.

Union is characterized by large relative price responses to both types of disturbance, with particularly large responses to demand disturbances. The output responses to demand disturbances are relatively small, indicating that most of the adjustment to demand disturbances occurs through relative prices, and not through output adjustment. Within the United States, the relative price responses are both relatively small and relatively slow, presumably reflecting the highly integrated nature of the goods and factor markets and the limitations to relative price adjustment brought about by having a common currency.

Comparing Aggregate Responses

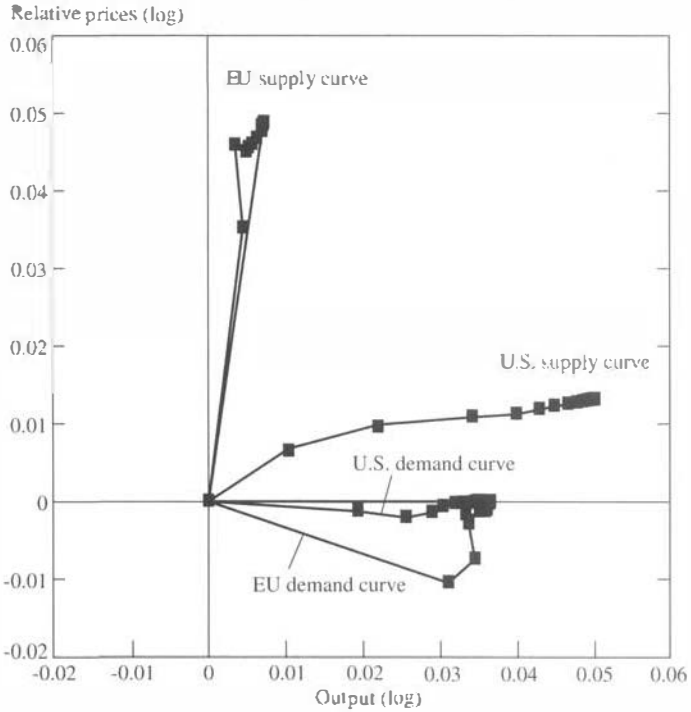
An alternative method of analyzing the impulse response functions is to look at the responses in relative price-output space. Recall from Figure 1 that a positive shift in the demand curve entails a movement up the supply curve. Similarly, a positive shift in the supply curve involves a short-run movement down the demand curve, followed by a movement back along the supply curve as the demand curve shifts outward over time. Hence, a scatter plot of the impulse response functions with respect to output against the impulse response functions with respect to relative prices should track the underlying demand and supply curves.

The results from such a scatter plot are shown in Figure 4. To compare the behavior of a typical EU country with that of a typical region in the United States, the graph uses the average responses across the EU countries and the average responses across the U.S. regions rather than showing the results for any specific country or region.[20]

The two curves in the upper right-hand quadrant of Figure 4 trace out the supply curve for the typical EU country and that for the typical region of the United States. In the case of the European Union, the supply curve is close to vertical, with almost all of the adjustment coming through movements in relative prices and virtually no output response. By contrast, the supply curve for the typical region in the United States has more of the adjustment coming through output than through prices. In addition, there is a distinct flattening of the estimated curve over time, which

[20] There is a problem in aggregating countries or regions with responses that are perverse, since it is not clear which "incorrect" sign should be used. Fortunately, when the normalizations shown in Figures 2 and 3 are used, the perverse responses are generally very small, and hence the incorrect values make very little difference to the results. The one exception is the output response to a demand shock in the Far West region of the United States. Hence, for the demand responses the Far West region was excluded from the U.S. data.

Figure 4. *Adjustment to Disturbances: EU Countries and U.S. Regions*



Note: The graph shows the average supply and demand curves for the European Union and United States derived from the estimated response of output and relative prices to underlying disturbances. Since the responses are measured using logarithms, a change of 0.01 is approximately equal to 1 percent.

is consistent with labor migration in response to disturbances. Both results plausibly reflect the higher level of integration of factor markets within the United States.[21]

The length of the estimated curves indicates the average size of the underlying disturbances, while the check marks represent adjustment in each year. In the European Union, adjustment is relatively rapid, being virtually complete within two years. By contrast, in the United States less than half of the long-run adjustment occurs within two years. Hence, despite its significantly smaller size, relative price adjustment is considerably slower in the United States.

[21] Blanchard and Katz (1991) discuss the operation of regional labor markets in the United States in detail.

The initial segment of the lines in the bottom right-hand quadrant traces out the demand curves within the European Union and the United States. The demand curve for the typical EU country has a negative slope that is about 35 degrees below the horizontal, indicating that both output and relative prices respond significantly to supply disturbances. By contrast, the short-run demand curve for the typical region in the United States is very flat, with almost all of the adjustment coming through movements in real output and very little through movements in output prices. Regional goods are very close substitutes in the United States, while there is more differentiation of goods across the European Union. Both estimated demand curves are appreciably flatter than the estimated supply curves, indicating that goods markets are more integrated than factor markets.

The initial disturbance to output is somewhat larger in the European Union than in the United States, which may reflect a wider diversity of technologies in Europe. Correspondingly, the adjustment in the United States is significantly slower than in the European Union, which presumably indicates the greater importance of movements of factors of production (in particular labor) in the adjustment to supply disturbances within the United States.

Overall, the most striking differences between the two areas are the very different underlying supply curves and the slower rate of adjustment in the United States. These results can be interpreted as meaning that the lower integration of goods and (particularly) factor markets in the European Union implies the need for a significant degree of relative price flexibility in Europe in order to adjust to underlying disturbances. As discussed earlier, much of this flexibility is currently provided by adjustable nominal exchange rates. Such relative price flexibility is less important in the United States since more of the adjustment occurs through real output via integrated goods and factor markets. This allows the United States to operate a common currency without significant economic disruption, although the importance of movements of labor and capital does mean that adjustment is relatively slow.

The implication is that, without higher factor mobility, introduction of a common currency in the European Union could cause significant economic disruption by limiting the flexibility of relative prices. There is, however, an alternative interpretation of Figure 4 that is rather more supportive of a single European currency. Instead of being an equilibrating response to underlying disturbances, the large movements in relative prices observed in the demand response of the European Union could reflect excess volatility in nominal exchange rate markets. According to this view, the introduction of a common currency would simply lower the

Table 3. *Variability of the Underlying Disturbance over Time*

	1963–72	1973–80	1981–89
EU demand	0.99	1.07	0.91
EU supply	0.85	1.26	0.95
U.S. demand	0.96	1.14	0.91
U.S. supply	0.81	1.15	0.89

Note: The table reports the average of the standard deviations of the underlying demand or supply disturbances for each individual EU country or U.S. region over the relevant period.

observed volatility in relative prices. While there may well be some truth to this view, there are at least two reasons for thinking that it does not present the whole story. While smaller than those across EU countries, estimated long-run relative price movements across U.S. regions are not inconsiderable.[22] Also, as will be discussed below, the long-run relative price response of EU countries that were members of the snake and the ERM (arrangements designed to limit nominal exchange rate fluctuations) are similar to those of countries that were not involved in these arrangements, but their relative prices adjust at a slower rate. Hence, these mechanisms appear to have slowed the speed of response of relative prices without having reduced the size of the underlying adjustment.

It is also of interest to look at the size of the underlying disturbances over time. Economic integration in the European Union could have led to a significant fall in the size of the underlying disturbances over time, implying smaller required movements in relative prices and output across countries. To investigate this possibility, Table 3 reports the average size of the underlying disturbances for the European Union and the United States for three periods: 1963–72 (1966–72 for the United States), 1973–80, and 1981–89. The aggregate values are measured by calculating the variation in the disturbances for each country or region separately and averaging them.[23] Since each shock is normalized to have a standard deviation of 1 over the estimation period, any deviation from unity indicates disturbances that were larger or smaller compared with the entire period. The results indicate a fall in the variability of both demand and supply disturbances in the European Union in the 1980s compared

[22] As will be discussed below, the long-run real exchange rate adjustment in the raw material producing regions of the United States is about half that estimated for EU countries, despite the existence of a common currency and large associated movements in regional output.

[23] One reason for averaging them was that the individual results indicated the existence of a considerable amount of noise.

with the 1972–80 period, but very little change compared with the 1960s. This is very similar to the path evident in the U.S. data, indicating that the higher variability of the disturbances in the 1970s probably reflects the economic turbulence caused by the two oil shocks. There does not appear to have been an independent downward trend in demand and supply shocks within the European Union over time.[24]

Behavior within the Regions

Thus far the comparisons have been between the typical behavior of an EU country and that of a region in the United States. However, as noted earlier, countries that were original members of the European Union appear to behave somewhat differently from those that entered the European Union at a later date. Similarly, within the United States the behavior of regions that are heavily concentrated in producing raw materials appears somewhat different from the remainder.

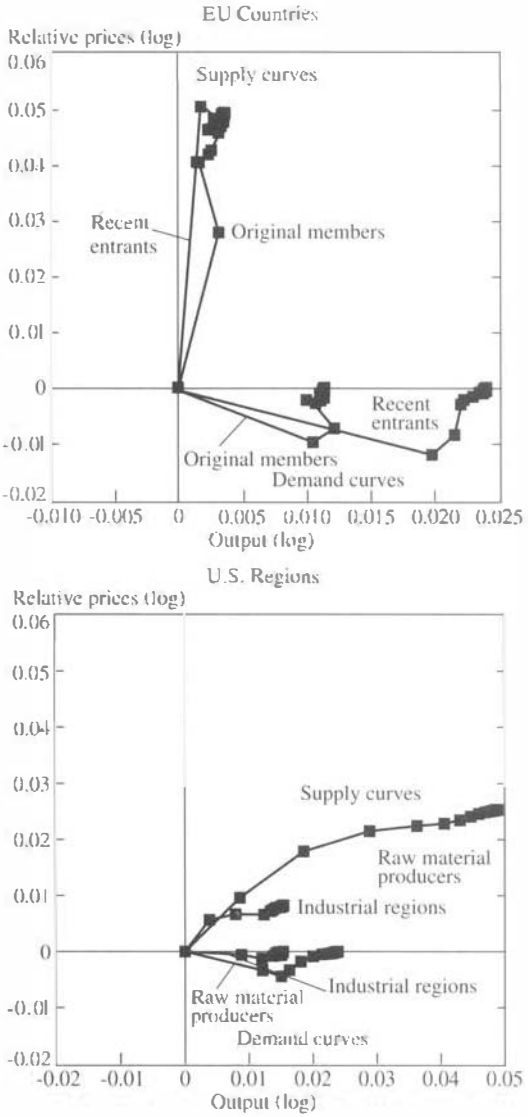
Figure 5 shows the responses for these groups separately. The results for the European Union show both interesting differences and some striking similarities between the two sets of countries. Consider first the supply curves traced out in the upper right-hand quadrant of the graph. Both curves are very steep and have almost identical lengths. However, while the later EU entrants reach the new equilibrium almost immediately (relative prices move by almost 4 percent in the first year), the speed of adjustment for the original EU members is significantly slower. This slower rate of adjustment plausibly reflects the greater commitment to inter-European exchange rate stability of the original EU members, through mechanisms such the ERM in the 1980s and the snake in the 1970s, as reflected in their lower observed relative price volatility (see Table 1).[25]

Turning to the lower right-hand quadrant, the results indicate that the slope of the short-run demand curve is relatively similar across the two

[24] The disturbances were also divided between long-term members of the European Union and more recent entrants. Except for the relatively low level of demand disturbances for long-term EU members in the 1970s, there were no large differences in behavior between the groups.

[25] Table 1 indicates that Denmark and Ireland, which are later EU entrants, also had relatively low real exchange rate volatility. When Denmark and Ireland are included with the original EU members and excluded from the later EU entrants, the results are similar. In a similar vein, results for a smaller group of core EU countries, consisting of Germany, the Netherlands, and Belgium, show very similar results to those for all long-term members of the European Union.

Figure 5. *Adjustment within the European Union and the United States*



Note: The graph shows average supply and demand curves for different types of countries within the European Union and regions within the United States. The curves are derived from the estimated responses of output and relative prices to underlying disturbances. Since the responses are measured using logarithms, a change of 0.01 is approximately equal to 1 percent.

groups of countries, implying a similar level of goods market integration. However, there does appear to be a significant difference in the size of the underlying disturbances. While an average disturbance changes real output in the original EU countries by 1 percent, it increases output for newer entrants by over 2 percent. The smaller underlying supply disturbances in the original EU members may reflect their greater homogeneity in technology and industrial structure.[26] In both cases, the adjustment occurs very quickly, essentially within a year.

The top right-hand quadrant of the graph for the U.S. regions (Figure 5) indicates that the slopes of the supply curves for the raw material producers and for the more industrial regions are very similar. However, the underlying demand disturbances, which are traced out by these lines, are much larger for the raw material producing regions than for the industrial regions, although the speed of adjustment is not dissimilar. The basic pattern of similarly sloped curves but larger disturbances for the raw material producing regions also holds in the lower right-hand panel of the graph. Both sets of regions have relatively flat demand curves. However, the size of the supply disturbances for raw material producing regions is double that for industrial regions.

These results indicate that the slopes of the estimated demand and supply curves are relatively stable both in the European Union and in the United States. Hence, while differences in adjustment *between* the European Union and the United States largely reflect the lower level of market integration in the European Union compared with the United States, differences in behavior *within* the United States and the European Union reflect variations in the size of the underlying disturbances.

V. Conclusions and Implications for EMU

This paper has used structural vector autoregressions of the type proposed by Blanchard and Quah (1989) to look at the response of output and relative prices to supply and demand shocks within the European Union and within the United States. The results indicate that, at least between the 1960s and 1980s, the United States had significantly more

[26] Bayoumi and Eichengreen (1993) find a similar result, namely that aggregate supply disturbances are more highly correlated for Germany and its immediate neighbors than for the rest of the European Union, the implication being that relative disturbances (which are measured in this paper) will be smaller for core members than for the rest of the European Union.

integrated goods and factor markets than the European Union. As a result, relative prices were more important for adjustment within the European Union than within the United States, even though the estimated underlying disturbances were of a similar size. Adjustment occurred more quickly within the European Union, presumably reflecting the flexibility in relative prices implied by adjustable nominal rates of exchange.

What are the implications for EMU? By adopting a single currency, the European Union is likely to reduce the short-run flexibility of relative prices, making it more difficult and costly to adjust to underlying disturbances. Given the very steep estimated supply curve, this will be particularly important in response to demand disturbances. Indeed, the exchange rate turmoil in 1992 and 1993 can be seen as an example of this, with the ERM structure making it difficult for relative prices in the European Union to respond sufficiently quickly to the rise in demand for west German products caused by German unification.

In the longer term, increasing integration of EU goods and factor markets should reduce the need for large movements in relative prices. Institutional changes, such as the recent completion of the single market in the European Union, are important in promoting this integration. In addition, EMU itself will probably promote greater flexibility than has been seen in the past. With the exchange rate instrument no longer available, the incentive for greater flexibility in domestic prices and factor markets is clearly greater, while a single monetary policy may allow larger inflation differentials than those deemed acceptable by national central banks.

Having said this, it does not appear likely that the European Union will achieve anything like the levels of integration of U.S. regions in the immediate future. In the shorter run, disruptive relative price adjustments can probably be best avoided by reducing the size of underlying disturbances in demand for regional products. Coordination of domestic aggregate demand policies across EU countries, such as the fiscal restraints incorporated in the Maastricht Treaty, can be seen as one method of easing the growing pains likely to be associated with EMU.

APPENDIX 1

A Simple Macroeconomic Model

This appendix presents a simple macroeconomic model of regional supply and demand. Consider a world made up of a large number of regions with identical

economic structures. Output in region i is produced using a Cobb-Douglas production function:

$$y_i = \phi_i + \alpha l_i + (1 - \alpha)k_i, \tag{A1}$$

where ϕ_i is the logarithm of a productivity disturbance, and y_i, l_i, and k_i are the logarithms of output, labor, and capital, respectively. Assume that labor and capital respond to changes in relative prices in the following way: $l_i = \gamma w_i/(1 + \gamma)$ and $k_i = \kappa r_i/(1 + \kappa)$, where w_i and r_i are the logarithms of wages and the rental rate of capital and γ and κ measure the responsiveness of factor demands to charges in factor prices. Then, for small changes in the underlying variables, the supply curve is

$$y_i = \left(1 + \frac{\gamma\alpha}{(1 - \alpha)(1 + \gamma)} + \frac{\kappa(1 - \alpha)}{\alpha(1 + \kappa)}\right)\phi_i + \left(\frac{\gamma\alpha}{(1 - \alpha)(1 + \gamma)} + \frac{\kappa(1 - \alpha)}{\alpha(1 + \kappa)}\right)p_i. \tag{A2}$$

The slope of the curve depends upon the degree to which factors move in response to differences in rates of return. If factors do not move at all between regions, then the curve is vertical; by contrast, if both labor and capital are fully mobile, the coefficient on p_i is $(\alpha/(1 - \alpha) + (1 - \alpha)/\alpha)$.

Demand for local goods comes from workers, who receive wages, and capitalists, who earn income from the ownership of capital. It is assumed that workers consume only their locally produced good, y_i, while capitalists have consumption that is fully diversified across all regions. All capitalists have the same preferences, given by

$$U^K = \sum_j (1 - \sigma)(c_j - \epsilon_j), \tag{A3}$$

where U^K is the utility function of capitalists, and c_j and ϵ_j are the logarithms of consumption of good j and of a preference disturbance, respectively. For small changes in variables, the logarithm of the demand curve for local goods is

$$c_i = \alpha(w_i + l_i) + (1 - \alpha)\left(\epsilon_i - \frac{p_i}{\sigma}\right), \tag{A4}$$

where w_i is the real wage of workers in terms of local goods. The first term shows the demand for local goods from workers; since they only consume local products it depends only on their real income. The second term, which represents demand from capitalists, depends only on local prices and not on incomes. (Since the demand of capitalists for local goods makes up only a small fraction of the total incomes of capitalists, changes in the rate of return on regional capital have no impact on demand.) The coefficients α and $(1 - \alpha)$ reflect the weight of the two types of demand in total consumption.

It is assumed that both real wages and labor input are fixed in the short run, so that all short-run changes in income accrue to capitalists. In this case, the short-run demand and supply curves for local products are

$$s_i = y_i = (1 + \lambda)\phi_i + \lambda p_i \text{ and } d_i = y_i = (1 - \alpha)\left(\epsilon_i - \frac{p_i}{\sigma}\right), \tag{A5}$$

where $\lambda = \kappa(1 - \alpha)/\alpha(1 + \kappa)$. Demand and supply disturbances act exactly as in the usual demand and supply diagram. As the labor market adjusts, real wages

and labor input both change. The resulting redistribution of income from capitalists to workers causes an endogenous change in demand for products. Assuming that labor remains immobile,[27] the long-run demand and supply curves are

$$s_t = y_t = (1 + \lambda)\phi_t + \lambda p_t$$

and

$$d_t = y_t = \alpha y_t + (1 - \alpha)\left(\epsilon_t - \frac{p_t}{\sigma}\right). \tag{A6}$$

A positive demand or supply disturbance that raises output induces a subsequent expansion in demand equal to proportion α of the original change in output. This process will continue, causing demand to steadily expand over time.

APPENDIX II

The Estimation Methodology

This appendix presents the estimation methodology. Consider a system where the model can be represented by an infinite moving average representation of a (vector) of variables, X_t, and an equal number of shocks, ϵ_t. Formally, using the lag operator L,

$$\begin{aligned} X_t &= \mathbf{A}_0\epsilon_t + \mathbf{A}_1\epsilon_{t-1} + \mathbf{A}_2\epsilon_{t-2} + \mathbf{A}_3\epsilon_{t-3}\ldots. \\ &= \sum_{i=0}^{\infty} L^i \mathbf{A}_i \epsilon_t \end{aligned} \tag{A7}$$

where the matrices $\mathbf{A}_i$ represent the impulse response functions of the shocks to the elements of X.

Specifically, let X_t be made up of the change in relative prices and the change in output, and let ϵ_t be supply and demand shocks. Then the model becomes

$$\begin{bmatrix} \Delta r_t \\ \Delta y_t \end{bmatrix} = \sum_{i=0}^{\infty} L^i \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \epsilon_{st} \\ \epsilon_{dt} \end{bmatrix}, \tag{A8}$$

where r_t and y_t represent the logarithms of relative prices and output respectively; ϵ_{st} and ϵ_{dt} are independent supply and demand shocks; and a_{11i} represents element a_{11} in matrix $\mathbf{A}_i$.

Demand and supply shocks are identified by assuming that, while demand shocks have permanent effects on relative prices, supply shocks have only temporary effects. Since relative prices are measured as first differences, this implies that the cumulative effect of supply shocks on the change in relative prices (Δr_t) must be zero:

$$\sum_{i=0}^{\infty} a_{11i} = 0. \tag{A9}$$

[27] If labor is regionally mobile this will cause a flattening of the supply curve over time (see equation (A2)).

The model defined by equations (A8) and (A9) can be estimated using a vector autoregression (VAR). Each element of X_t is regressed on lagged values of all the elements of X. Using $\mathbf{B}$ to represent these estimated coefficients, the estimating equation becomes

$$\begin{aligned} X_t &= \mathbf{B}_1 X_{t-1} + \mathbf{B}_2 X_{t-2} + \cdots + \mathbf{B}_n X_{t-n} + e_t \\ &= (I - \mathbf{B}(L))^{-1} e_t \\ &= (I + \mathbf{B}(L) + \mathbf{B}(L)^2 + \cdots) e_t \\ &= e_t + \mathbf{D}_1 e_{t-1} + \mathbf{D}_2 e_{t-2} + \mathbf{D}_3 e_{t-3} + \cdots, \end{aligned} \tag{A10}$$

where e_t represents the residuals from the equations in the VAR. In the case being considered, e_t is comprised of the residuals of a regression of lagged values of Δr_t and Δy_t on current values of each in turn, labeled e_{rt} and e_{yt}, respectively.

To convert equation (A10) into the model defined by equations (A8) and (A9), the residuals from the VAR, e_t, must be transformed into the demand and supply shocks, ϵ_t. Writing $e_t = \mathbf{C}\epsilon_t$, it is clear that, in the 2×2 case considered, four restrictions are required to define the four elements of the matrix $\mathbf{C}$. Two of these restrictions are simple normalizations, which define the variance of the shocks ϵ_{yt} and ϵ_{dt}. A third restriction comes from assuming that demand and supply shocks are orthogonal.

The final restriction, which uniquely defines the matrix $\mathbf{C}$ is that supply shocks have only temporary effects on relative prices. This implies

$$\sum_{i=0}^{\infty} \begin{bmatrix} d_{11i} & d_{12i} \\ d_{21i} & d_{22i} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} = \begin{bmatrix} 0 & \cdot \\ \cdot & \cdot \end{bmatrix}. \tag{A11}$$

This restriction allows the matrix $\mathbf{C}$ to be uniquely defined and hence the demand and supply shocks are identified.

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Determining the Value of a Financial Unit of Account Based on Composite Currencies: The Case of the Private ECU

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The paper presents evidence from the past three years which indicates that the exchange rate between the private ECU and the official ECU Basket can deviate substantially from par. The value of the private ECU is driven by expectations that a future European Central Bank will enforce par convertibility between the private ECU and the official ECU basket of currencies. Meanwhile, no existing institutional arrangement limits the private ECU's value in terms of the Basket. This paper addresses the question of what determines the values of the private ECU and of private ECU interest rates. We show that an anticipation of a future fixing of the private ECU's value, together with the interest rate setting mechanism of the large-value ECU payment and clearing system, are sufficient to determine its value. The determination of the private ECU exchange rate provides the template for how to determine the value of any private composite currency, such as, for example, a private SDR. [JEL E42, E43, E58, F31]

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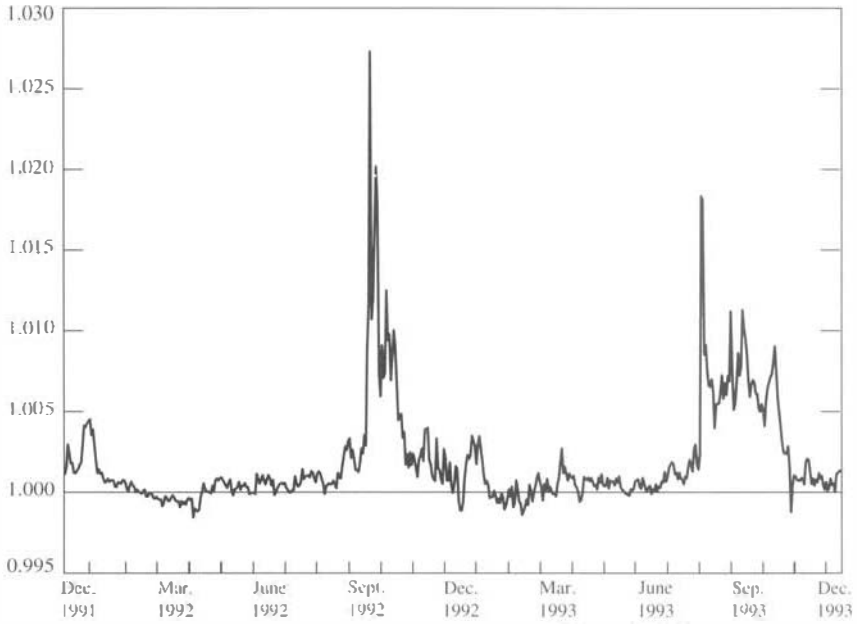
IN A DECADE marked by far-reaching developments in the world's financial industries, among the most extraordinary has been the rapid growth in claims denominated in a market-created unit of account based on a basket of currencies—the private European currency unit (ECU). The use by market participants of the ECU unit of account to denominate financial assets was stimulated when European monetary authorities began to use the official ECU—defined as a basket of fixed amounts of the 12 European Union (EU) currencies—to denominate some types of official transactions. Nevertheless, there is an important difference between the official and the private ECU. The official ECU is, by agreement among these authorities, exchangeable into the fixed basket of currencies (the Basket) at par or into an equivalent value of a single currency, while no active official or private market mechanism currently guarantees a one-for-one exchange of private ECUs into units of the ECU Basket. The holder of ECU-denominated bank deposits cannot expect to convert these into the Basket at par at all times, nor can the owner of an ECU-denominated treasury bill or bond valued in ECU convert the asset into an equal value in units of the Basket.

Although initially the private ECU exchanged for the Basket very near its par value, recent market experience has shown that the value of the private ECU can deviate substantially from the value of the Basket. Such deviations from parity have been significantly larger than is explainable in terms of bid-ask spreads. Private ECU can be purchased and sold in exchange for the Basket at market-clearing rates of exchange in a market made by some of the major ECU-clearing banks. Typical bid-ask spreads between the ECU and the Basket are four to five basis points. As shown in Figure 1, from end-1991 onward, a period of increasing optimism about the successful move toward European Monetary Union (EMU), the ECU began to command a significant exchange rate premium over the Basket, which reached a peak of 100 basis points in January 1991. The value of a private ECU in terms of any given currency had come to exceed the value of the Basket in terms of the same currency. During the exchange rate mechanism (ERM) crisis in September 1992, however, the exchange rate between the private ECU and the Basket depreciated up to 250 basis points from par because of a combination of exchange controls in some of its component currencies, large sales of ECU from official reserves as official holders made "substantial withdrawals of deposits," and a general flight from ECU securities. The market did not operate for a week after September 16, 1992—that is, holders of ECU claims found that the claims were not convertible with the Basket. Not until the end of October 1992 did the private ECU begin once more to exchange at close to par (BIS (1993), p. 5). Again, in the second ERM crisis in July

Figure 1. *ECU/Basket Exchange Rates*



Source: Kredietbank N.V., Belgium

and August 1993, the ECU depreciated up to 180 basis points from par, remained 50 to 100 basis points from par until October 1993, and returned close to par only at the end of October.

These deviations from parity challenge belief in the existence of some arbitrage opportunity that keeps the ECU near par. If such beliefs permeate the market so that the foreign exchange risk of the private ECU against the Basket is not yet fully reflected in the current discount of the private ECU against the Basket or in the ECU yields, this discount could widen further in the absence of official support.

That the exchange rate between the private ECU and the Basket can move substantially from par raises fundamental questions: what factors influence the ECU's value and what institutional mechanism determines the yield on ECU-denominated assets?

An understanding of the determination of the ECU/Basket exchange rate and its volatility is necessary for an assessment of the foreign exchange risk relative to the Basket associated with holding ECU-denominated assets and for the management of the foreign exchange risk

of open positions in private ECU, particularly on bank balance sheets. More generally, the developments in the private ECU market provide valuable experience about the value in component currencies of any private unit of account that adopts the name of a given currency melange. This experience is of particular relevance in engineering the development of additional potential private composite currencies, such as regional composite currencies or a private special drawing right (SDR). Though we consider such questions in the context of the private ECU, the conditions and institutional underpinning that activate a unit of account, giving determinate value and eventual use as a payment medium, are fully applicable to other units such as the SDR.

I. The Private ECU: What Is It Worth?

Private ECUs are ECU-denominated time or current deposit liabilities of the banking sector.[1] Payments for financial transactions in ECU-denominated instruments—for example, private and public sector bonds, notes, futures contracts, and bank loans—are made in ECU-denominated deposit liabilities of designated banks.

The bulk of the ECU securities are issued by European governments, European Union institutions, or supranationals. Publicly owned financial institutions also account for a large fraction of the number of ECU securities issues. Commercial corporations currently account for less than 20 percent of the number of issues. Banks acquire ECU securities to balance ECU-denominated liabilities to customers. The growth in the size of issues, the development of benchmarks, and the increase in liquidity also made it possible for the two largest European futures exchanges—LIFFE in London and MATIF in Paris—to launch success-

[1]The official ECU, created in a definition contained in a resolution of the European Council of December 5, 1978, is a unit of account consisting of fixed amounts of the currencies of all 12 member states of the EU. Its value in terms of another currency can be calculated by converting the fixed amounts of constituent currencies into a common currency at prevailing bilateral exchange rates. The official ECU is created as a liability of the European Monetary Cooperation Fund (EMCF) by swapping such ECUs for gold and international reserves held by central banks participating in the European Monetary System (EMS). In July 1993, the EMCF had about ECU 51 billion in liabilities outstanding through swap operations. Official ECUs can be used only in transactions with EU central banks and a limited number of monetary institutions designated as Other Holders of ECUs. Official ECUs are also created through the Very Short-Term Financing Facility (VSTFF) established in the Basle-Nyborg agreement to provide inter-central-bank credit in the defense of the bands of the European Exchange Rate Mechanism.

fully a short- and a long-dated ECU interest rate contract. The rapid growth of the ECU securities market has been matched by that of the ECU banking markets. By the end of 1991, the private ECU had become the unit of denomination for about ECU 141 billion of bonds and bills. ECU-denominated bonds also accounted for more than 15 percent of total secondary market turnover in the international bond market.[2] ECU-denominated bank assets grew from ECU 64 billion at the end of 1985 to ECU 184 billion at the end of 1991. During the same period, ECU-denominated liabilities grew from ECU 58 billion to ECU 193 billion. Of these 1991 liabilities, however, ECU 153 billion were interbank claims. The magnitude of ECU securities and bank balance sheets each represented approximately 5 percent of EU totals at current exchange rates.

In 1989, central banks began to employ the ECU to manage reserves, thereby adding to the demand for ECU securities. Central banks acquired such large amounts of ECU-denominated claims that, by September 1991, total official holdings of private ECUs amounted to ECU 34.1 billion of the ECU 40 billion of overall non-interbank deposits. Thus, ECU deposits are overwhelmingly made up of official claims, mainly counted in the official reserves of central banks.[3]

Is There a Monetary Mechanism to Give Real Value to the ECU as Unit of Account?

To shed light on what is required to determine the real value of the private ECU unit of account, we review some basic monetary theory on the determination of the real value of a general unit of account.[4] Consider first a real economy,[5] to which is added a nominal currency yielding zero interest and measured in a unit of account such as deutsche mark (DM).

To ensure that the DM unit has determinate prices in terms of goods and services, it is necessary that there be well-defined demand and supply functions for the currency. The use of currency, for example, might lower the cost of making transactions and thus generate a real demand for currency. The monetary authority can then exogenously set the supply

[2] Since the exchange rate crisis of September 1992, ECU bank assets have been flat and securities issuance has declined substantially.

[3] See Goldstein and Folkerts-Landau (1993).

[4] See Patinkin (1961) or Fama (1980).

[5] A real economy is without a pure nominal commodity or unit of account to serve as numeraire; instead, prices are stated in terms of a real good numeraire, e.g., in terms of steel ingots.

of DM currency to ensure a well-defined equilibrium in the DM currency market, which yields the price of a DM in terms of goods and services.

Alternatively, bank deposits can also be used to define the real value of a nominal DM unit of account. Specifically, the monetary authority can require that banks hold reserves against deposits in the form of non-interest-bearing central bank obligations denominated in DM. As long as deposits have attributes that make them a low-cost transaction medium, there will exist a real demand for deposits (despite the reserve requirement tax) and hence for reserves at the central bank. By controlling the nominal supply of reserves and by setting the interest rate on these reserves, say at zero,[6] the monetary authority determines the real value of the DM unit of account.[7] It has solved the problem of "giving content to a pure nominal unit of account (a DM) as a separate, well-defined economic good."[8]

Application of this analysis to the private ECU makes apparent that there does not yet exist such a monetary mechanism to impart a determinate value to the private ECU unit of account. In particular, ECU-denominated bank liabilities lack the attributes, such as being a low-cost medium for transactions external to the system of ECU financial institutions, that could produce a well-defined stable demand. Furthermore, there is no mechanism, such as a reserve requirement and a limited supply of ECU-denominated instruments for final settlement outside the private banking system, to control the growth of the ECU-denominated monetary liabilities of the banking system. We are thus left to look elsewhere for the mechanism that determines the real value of the ECU unit of account.

Can the ECU/Basket Exchange Rate Be Fixed through the Payments Mechanism?

In the absence of a monetary mechanism, the value of the private ECU can be determined, if a syndicate of banks or monetary authorities stands ready to exchange the private ECU for the Basket at par, by fixing

[6] It should be noted that in order to get a determinate real value of currency or reser es, it is *necessary* for the monetary authority to fix exogenously the interest rate on currency and reserves. Otherwise, no determinate price of reser es in terms of goods emerges, since a continuum of own currency interest rates and price levels could ser e to equate demand and supply in the market for reserves (Patinkin (1961)).

[7] In practice, the monetary authority controls the sum of currency and reser es, allowing banks to exchange currency for reser es on demand at a fixed price.

[8] See Fama (1980).

the private ECU/Basket exchange rate through some private or official guarantee.

Until October 1987, the value of the private ECU—that is, ECU-denominated bank liabilities—in terms of any other currency was firmly pegged to the value of the Basket by the daily clearing operations of the ECU-clearing banks. In particular, clearing banks that emerged from the daily ECU clearing owing ECU were permitted to deliver the Basket. Hence any movement of the ECU/Basket exchange rate from par, say in the direction of an ECU premium, would have provided an opportunity for some banks to earn arbitrage profits by buying the Basket with private ECU and then using the Basket to settle any negative clearing balances in the private ECU clearing and settlement system at par.[9] Similarly, if the ECU were at a discount, creditor banks could have forced the delivery of the Basket by not granting overnight ECU loans to net debit banks.

This mechanism to peg the value of the private ECU to the Basket fully determined the real value of the private ECU. It initially gave the ECU, as unit of account, determinate prices in terms of real goods and services indirectly through the value of the Basket currencies. The mechanism broke down in October 1987, however, because the increased reluctance of some clearing banks to accept Baskets in settlement for large ECU-debit clearing balances frequently put a day's clearing at risk.[10]

From October 1987 to November 1988, a single bank, the Kredietbank N.V. of Belgium, continued to exchange private ECU for Baskets at par. During this period the nonbank sector's holding of ECU bank loans continued to grow faster than its ECU bank deposits. Most ECU banks passed on their net long ECU positions to Kredietbank by selling ECU against the Basket and borrowing their resulting net debit in ECU payments from the buyer, Kredietbank. Kredietbank was eventually forced to discontinue exchanging the ECU against the Basket at par once it recognized the risk of cumulating an unbalanced ECU position. Thus, since November 1988, there has not existed any private institutional arrangement or commitment to exchange the private ECU for the Basket at par.[11]

[9]The ability to settle interbank clearing balances in either private ECU or Baskets also meant that banks with short or long positions in private ECU did not incur much exchange risk and could make a two-way market in ECU against the Basket with low risk.

[10]A further technical difficulty contributed to the breakdown of the clearing arrangements. The delivery of some component currencies occurred too late during the clearing day to be lent out overnight.

[11]Two banks make a two-way market in ECU against the Basket and a further three banks make a two-way market in ECU against single currencies. We will refer to these as core banks. Most other banks have a matched ECU book.

Currently, most ECU banking activity is undertaken by the 44 clearing members of the ECU Banking Association (EBA). The Bank for International Settlements (BIS), as agent for the EBA, operates an ECU clearing and settlement system, which functions on an end-of-day net settlement basis.[12] Since settlement of a day's ECU balances no longer occurs in the Basket or in any medium provided by a source external to the private banks, banks that are net debtors on a day's ECU payments must borrow ECUs from the day's net creditor banks. Lack of required settlement in an external medium has slammed the door to determining the value of the private ECU unit of account in the course of settlement and, except for the exchange market, has made the private ECU a self-referential system.[13]

Can Monetary Authorities Fix the ECU/Basket Exchange Rate?

There never existed any official mechanism or guarantee to convert private ECUs one-for-one into the Basket. A commitment by an individual central bank, or a group of central banks, to fix the ECU/Basket exchange rate would have the same monetary consequences as fixing the exchange rate between any two currencies: it would require that the central banks stand ready to convert ECU-denominated bank liabilities into claims on themselves. Since there is currently no effective way to control the expansion of such ECU-denominated bank liabilities, for example, through a reserve requirement on ECU deposit liabilities, any attempt by a single central bank to fix the ECU/Basket exchange rate could result in a serious loss of monetary control. Specifically, a central bank defending its own currency through a squeeze would have the policy undermined by a banking system creating ECU deposits and exchanging them for domestic currency.

Can Market Arbitrage Fix the ECU/Basket Exchange Rate?

The opinions of many market participants are based on the assumption that there exists an arbitrage possibility that can move the ECU/

[12] Average daily turnover on this system grew from ECU 21.4 billion in January 1990 to ECU 43.2 billion in May 1992, reaching a peak of ECU 156 billion in September, and declining back to a more normal ECU 45 billion in October 1992, a level that persisted through September 1993.

[13] In national currencies, settlement of end-of-day balances in the banking system is usually done in claims on the central bank, that is, in a good funds medium from outside the private banking system.

Basket exchange rate toward parity.[14] No such arbitrage is available, however—only a speculation on the future value of the ECU. If, for example, the private ECU trades at a discount against the Basket, a bank could fund ECU assets with Basket liabilities. However, the bank would then have an open position in ECU. As in any other currency market, a bank or even a syndicate of banks cannot risk assuming an unlimited open position on a belief that market sentiment will change. While such a transaction may temporarily be successful in affecting the exchange rate, it cannot in the longer run counteract changing market expectations regarding the future value of the ECU in terms of the Basket. The bank would continually cumulate a long ECU position until it found the exchange risk excessive. At this point, it would trim its ECU position, as in any currency market.

We conclude therefore that currently there does not exist an active mechanism—private or public—to determine the real value of the private ECU unit of account nor to fix the exchange rate of the private ECU to the Basket at parity.[15]

II. The First Step toward Determining ECU/Basket Exchange Rate: An Interest Parity Condition

The efforts to move from the ERM toward EMU have generated expectations that during Stage III of EMU, the private ECU will be fixed

[14] As an example of the belief in the professional market literature that the ECU value was pinned down by arbitrage, see J.P. Morgan (1991). Starting in 1991, the literature on the ECU produced by major market institutions started to discuss the divergence between the ECU and the Basket and began to argue that there was no means of effecting an arbitrage, although some hinted that there might be some central bank intervention to stabilize the exchange rate. See, for example, EBA (1991); Paribas (1991b); Louw (1992); and Bishop (1991a) and (1991b). Nevertheless, in assessing the divergence, there was still a frequent misuse of the word "arbitrage." See, for example, Paribas (1991a).

[15] The emergence of the private ECU as a unit of account in its own right temporarily generated a lack of clarity in the meaning of a promise to deliver ECUs contained in ECU securities. The typical prospectus of an ECU security initially defines the ECU as the official basket, but then promises delivery in private ECU bank deposits. If these two units of account trade at par until the maturity of the security, no problem can arise. When they cease to trade at par, however, the promise of the securities becomes less clear. The exchange rate uncertainty could be removed quite easily from the market for nonbank securities if issuers were prepared to service such debt either in ECUs or in Baskets according to the demands of the holder. This would implicitly fix the ECU/Basket exchange rate applicable to nonbank markets but would add a multiple currency option risk to the security issuer. Since the official sector is the main issuer of ECU-denominated bonds, notes, and bills, such an initiative could easily be implemented by amending the prospectuses for such issues.

irrevocably to national EU currencies (not necessarily to the Basket as currently constituted).[16] Such expectations of a future fixing constrain the current value of the private ECU and are part of the mechanism that determines the ECU/Basket exchange rate. However, well-defined expectations regarding the future value of the private ECU alone are not sufficient to determine the ECU/Basket exchange rate. An additional requirement, as reviewed above, is that the term structure of ECU interest rates be tied down through the exogenous fixing of some ECU interest rate. These two conditions—well-defined expectations regarding a future fixing of the ECU/Basket exchange rate *and* an exogenously set ECU interest rate—together turn out to be sufficient to produce a determinate ECU/Basket exchange rate.[17] Analytically, well-defined expectations regarding the future fixing of the private ECU/Basket exchange rate allow us to derive an uncovered interest parity condition of the private ECU against the Basket. This interest parity condition then yields all equilibrium combinations of ECU interest rates and ECU/Basket exchange rates.

In addition to uncertainty regarding the future fixing of the ECU/Basket exchange rate, there also exists uncertainty about the future currency composition of the Basket and about the future spot bilateral exchange rates among the 12 ECU currencies.[18]

To describe these results analytically, let

$$W(t) = [W_1(t), \ldots, W_{12}(t)] \tag{1}$$

represent the official currency composition of the ECU at time t. For example, let the first entry, $W_1(t)$, be the quantity of DM in the Basket at time t. $W(0)$ is the official current composition of the ECU. The future

[16]The Maastricht Treaty formally provides for this in Article 109g and Article 109*l*(4).

[17]The Maastricht agreement of December 1991 generated a surge of activity in the ECU securities market. This agreement made the convergence to monetary union and the creation of a European Central Bank (ECB) more likely, and with that the private ECU was more likely to become the unit of account in a monetary union. At the end of 1991, the market included ECU 193 billion of banking liabilities, ECU 124 billion of bonds, and ECU 17 billion of Euro notes and treasury bills; in the first half of 1992, ECU primary bond issues totaling ECU 26 billion (compared with ECU 33 billion in all of 1991) were brought to the market. The currency turmoil put nearly a complete halt to new issues from August 1992 until February 1993. New issues have revived somewhat in 1993, but they remain far below the levels attained in the first half of 1992.

[18]Prior to Maastricht, the ECU was reconstituted every five years. The Maastricht Treaty froze the composition of the Basket, but since it is generally accepted that many of the countries will not meet the convergence criteria by 1997 or 1999, there is some doubt in the markets about how the ECU will be defined for those core countries that may satisfy the criteria.

composition of the Basket at time t, i.e., $W(t)$, is uncertain. Let the spot exchange rates between the DM and the currencies in the Basket be represented by

$$e(t) = [1, e_2(t), \ldots, e_{12}(t)] \tag{2}$$

in the same order as the currency shares in $W(t)$. Thus,

$$B(t)_{DM} = e(t) \cdot W(t) \equiv \sum_{i=1}^{12} e_i(t)\, W_i(t) \tag{3}$$

is the DM value of the Basket at time t.

As a first approximation, assume that it is expected with certainty that the exchange rate between the private ECU and the Basket, as officially defined at that time, will be fixed at par at the known time $t = T$; that is, a promise to deliver one ECU at time T is equivalent to a promise to deliver $W(T)$ at time T. The DM value of one ECU at time T will then be equal to the DM value of the Basket at time T, that is, equal to $e(T) \cdot W(T)$.

Since at time T both the composition $W(T)$ of the Basket and the future spot exchange rates, $e(T)$, are uncertain, the DM value of the private ECU at time T is uncertain. The present DM value of a private ECU deliverable at time T can be found by discounting the expected DM value, $E[e(T) \cdot W(T)]$, by the appropriate risk-adjusted DM discount rate, $i(T)_{DM}$, applicable to payments that mature at time T:

$$E[e(T) \cdot W(T)]/[1 + i(T)_{DM}]. \tag{4}$$

Alternatively, if $i(t)_{ECU}$ is the ECU discount rate now applicable to ECU deliverable at time t, then the present value of one ECU deliverable at time T is

$$\frac{1}{[1 + i(T)_{ECU}]}. \tag{5}$$

Taking the ratio of equation (4) to equation (5), the current market spot rate of ECU in terms of DM (DM per ECU) then is[19]

$$S(\bullet)_{ECU} = \frac{[1 + i(T)_{ECU}]}{[1 + i(T)_{DM}]} E\,[e(T) \cdot W(T)]. \tag{6}$$

[19] Instead of explicitly discounting the expected future DM value of one ECU by the risk-adjusted DM interest rate to obtain the present DM value of an ECU deliverable at time T, we could have replaced $E[e(T) \cdot W(T)]$ with the ECU/DM forward exchange rate and discounted by the observable DM interest rate of appropriate maturity. In this case, the risk premium generated by the uncertainty about $e(T)$ and $W(T)$ would have been embedded in the forward rate.

This expression for the ECU spot rate applies to the case in which the ECU/Basket exchange rate is fixed at parity at the known time T. If the fixing can occur at any time t, between now and time T, with probability $\pi(t)$ then the ECU spot exchange rate in terms of DM is the probability weighted average of the solutions for the certain future fixing:

$$S(0)_{\text{ECU}} = \sum_{t=1}^{T} \frac{(1 + i(t)_{\text{ECU}})}{(1 + i(T)_{\text{DM}})} E\,[e(t) \cdot W(t)]\pi(t). \tag{7}$$

The current spot exchange rate between the Basket, as currently defined, and the DM (DM per Basket) is

$$B(0)_{\text{DM}} = e(0)\,W(0). \tag{8}$$

The current spot price of the ECU in terms of the Basket is then given by[20]

$$\frac{S(0)_{\text{ECU}}}{B(0)_{\text{DM}}} = \frac{[1 + i(T)_{\text{ECU}}]}{[1 + i(T)_{\text{DM}}]} \cdot \frac{E\,[e(T) \cdot W(T)]}{e(0) \cdot W(0)}. \tag{9}$$

The cross-market arbitrage conditions in equation (6) or (9) resemble the traditional uncovered interest parity condition, that is, they determine the relationships between spot and future expected exchange rates and discount rates.[21] However, these condition do not produce a solution for the private ECU/DM nor for the ECU/Basket spot exchange rate in terms of individual currency exchange rates and interest rates. Rather, we have an expression for how the private ECU/DM spot rate and the interest rate of the private ECU should align in equilibrium. Any combination of $S(0)_{\text{ECU}}$ and $i(T)_{\text{ECU}}$ satisfying equation (6) defines a market equilibrium. Hence, the market equilibrium ECU/DM exchange rate, $S(0)_{\text{ECU}}$, as well as the market equilibrium ECU/Basket exchange rate, $S(0)_{\text{ECU}}/B(0)_{\text{DM}}$, are indeterminate. Equations (6) and (9) confirm a conclusion from the discussions in Section 1, namely, that it is necessary to determine an ECU interest rate if we want to obtain a determinate ECU/Basket exchange rate. We shall describe in the next section the mechanism that exogenously determines an ECU interest rate and thus removes the indeterminacy of the equilibrium spot exchange rates in equations (6) and (9).

[20] If the time of fixing is uncertain, then

$$\frac{S(0)_{\text{ECU}}}{B(0)_{\text{DM}}} = \sum_{t=1}^{T} \frac{(1 + i(t)_{\text{ECU}})}{(1 + i(t)_{\text{DM}})} \cdot \frac{E[e(t) \cdot W(t)]}{e(0) \cdot W(0)} \cdot \pi(t).$$

[21] The uncovered interest parity condition is given by $e = (1 + i_d)/(1 + i_f)Ee_f$, where e is the spot rate of exchange of domestic money exchange for foreign money, i_d and i_f are domestic and foreign interest rates, respectively, and Ee_f is the expected future spot exchange rate.

III. The Second Step toward Determining the Real Value of the Private ECU: Setting the ECU Interest Rates

This section explores the mechanism for setting an interest rate for the private ECU. The interest parity condition derived in the previous section yields all possible equilibrium combinations of ECU/Basket exchange rates and ECU interest rates. If there exists a mechanism that exogenously sets an ECU interest rate, then equation (9) will fully determine the private ECU/Basket exchange rate. Such a mechanism to set the ECU interest rates, in fact, currently exists as part of the ECU clearing and settlement system.

The ECU clearing system, centered around the ECU clearing banks, is organized by the ECU Banking Association (EBA). Same-day clearing of ECU payments orders on this system has been in effect since March 28, 1988. The ECU clearing and settlement system is unusual in that it does not settle clearing balances in a medium external to the banking system, such as reserves held at a central bank. Since the right to settle in the Basket was denied in October 1987, settlement has consisted of converting daylight net credit settlement positions into overnight interbank ECU loans.[22]

[22]The daily ECU clearing operation proceeds in three separate stages. Until the preliminary cut-off time of 2 p.m. (Brussels time) all payments messages between the clearing banks go through the Society for Worldwide Interbank Financial Telecommunications (SWIFT) network. A netting computer provides each bank with its own preliminary debit or credit netting balance and makes available to each bank the nature (debit/credit) of the balance of every other clearing bank (also entered into a Reuters page by the BIS). The netting center also transmits these final netting balances to the BIS. The BIS maintains a daily clearing account for each clearing bank, which is credited or debited with the final netting balances of each bank. If at 3:15 p.m. some banks' net positions still exceed ECU 1 million, a further half hour is allowed for an interbank market among the reduced set of participants—so-called special transfers. After this period, to deal with the remaining "small change" transactions required to bring the clearing accounts to a zero balance, the BIS, acting as an agent, arranges loans from the net credit banks to the net debit banks. To do this, the BIS maintains an ECU "sight account" for each clearing bank with a balance that cannot exceed ECU 1 million. These accounts pay zero interest and no overdrafts are permitted. The BIS can, at its discretion, transfer up to ECU 1 million in any one day from the account of one bank to the account of the other banks and log the transfer as an interbank loan between the two banks at the BIS overnight interest rate. Effectively, this is a housekeeping operation to eliminate frictional ECU clearing balances. If a clearing bank is unable to obtain sufficient ECU credit to settle its clearing balance, then the rules (never yet invoked) prescribe that the day's clearing will be unwound and all payments orders given and received by the nonperforming bank will be canceled. The remaining payment orders are automatically value-date adjusted to the next day.

Since there are no private ECUs other than bank IOUs, there is no way to settle a net debit position in the day's payments other than by converting it into an interbank overnight loan—that is, the debit bank remains a debtor to the remaining banks in the system. Until recently, the prearranged credit lines in the ECU system appear to have been sufficiently extensive to avoid problems in effecting this kind of settlement.[23] In practice, there appears to be a balanced distribution of ECU payments, so that no group of banks will continue to acquire claims on other banks; otherwise there would have to be a mechanism to settle claims in some other medium, such as ECU-denominated securities. If a creditor proved reluctant to extend further credit, the day's clearing operation could be jeopardized. To prevent this and potential manipulation of overnight ECU interest rates, the EBA has implemented a system of brokering overnight lending and administratively setting overnight ECU interest rates.

Since no actual ECUs for settlement exist, such as the ECU obligations of a European monetary authority, a net creditor bank cannot demand delivery of "ECU"—it must accept settlement in interbank ECU debt for the clearing to succeed. The net credit bank can always attempt to squeeze the net debit banks by refusing to make ECU loans, thus threatening the clearing. Similarly, a net debit bank can settle its accounts only by borrowing from a net credit bank. If it refuses to acquire a loan at a rate deemed unreasonable, it can also cause the settlement to fail. In this sense, any one bank can cause a settlement failure and squeeze the others to the extent that they wish to avoid the cost of such a failure. As a result, it has generally been accepted that the interest rate payable on overnight loans arising out of the clearing operation should be set outside the ECU banking system.[24] The BIS, as agent of the private ECU clearing and

[23]Nevertheless, because of growing recognition of the risk of difficulties in clearing a day's payment operation, several lending facilities have recently been established to provide credit to net debit banks. The BIS Intermediation Facility can lend f nds to a bank short of funds by taking up to ECU 5 million from each of the clearing banks and lending to banks that are short. In this way, it can spread the risk of the overnight credit among the clearing banks. The Bank of England, the Banque de France, and the Banca d'Italia have also introduced separate liquidity recycling facilities. These operate either as collateral management facilities, with the pledging by short ECU-clearing banks of ECU sight balances held at the central bank as collateral for lending by a long ECU-clearing bank, or as credit management facilities, with direct intermediation between long and short banks by central banks lending against ECU or national currency securities held in centralized securities depositories. At the writing of this paper, these facilities had not yet been used.

[24]Since the total net debit position of the clearing banks is always equal to their total net credit position on payments, it has been argued that *any* overnight

settlement system, sets this overnight interest rate according to well-defined rules.[25] In doing so, it also removes the indeterminacy of the ECU/Basket exchange rate in the interest parity equation.[26]

The Setting of Overnight ECU Rates

Suppose that an ECU clearing takes place on day D. To set the interest rate to be charged on overnight ECU lending between day D and day $D + 1$, the BIS acquires data on EIBOR (ECU Interbank Offer Rates) and EIBID (ECU Interbank Bid Rate) interest rates from the clearing banks as of about 12:00 p.m. on day $D - 1$. The BIS eliminates the high and low EIBOR rates supplied by the banks and takes an arithmetic average of the remaining rates to determine the EIBOR rate applicable for interbank loans between day D and day $D + 1$. A similar procedure is used to determine the EIBID rate.

To construct the EIBOR rate information that it supplies to the BIS, an individual bank collects its Basket currency tomorrow/next offered rates[27] at 12:00 p.m. on day $D - 1$. It then computes the weighted average of these rates, using the current weights of the currencies in the official ECU. The bank's EIBID rate is similarly computed using the tomorrow/next bid rates for the Basket currencies.

The actual rate that applies to debit balances on day D depends on the "imbalance" between the supply and demand of the ECU on the exchange market between ECU and currencies in the Basket. Since the exchange markets between ECU and Baskets and major currencies in the Basket operate as standard foreign exchange markets with two business days until settlement, the imbalance is determined on day $D - 2$. If the

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interest rate will clear the interbank market (Jean (1990)) and that, therefore, the interest rate must be set externally. It is always true, however, that net debits equal net credits on a day's payments. In the ECU system, they also equal net interbank lending because of the lack of other media to settle. Nevertheless, in the absence of a market manipulation, the market should clear through the emergence of credit risk premiums charged to individual debit banks.

[25] That the banks must occasionally clear this position through "special transfers," however, indicates that either there are some additional late payments or a set of unwritten rules exists for allocating risks among the creditor banks that are reluctant to lend to the debit banks.

[26] The exogenous interest rate setting rule also satisfies the requirement that the interest rate of some nominal instrument, such as required reserves, be set exogenously for the unit of account to have determinant real value. Note that any exogenous rate setting rule would do to make the value determinate, regardless of the theoretical rationale for choosing it.

[27] Interest rates on overnight loans made tomorrow and repayable the next day.

ECU banking system is in an aggregate net long position in ECU to be delivered to it in exchange for component currencies exceeding ECU 100 million in value—that is, it has bought private ECU in exchange for component currencies worth more than ECU 100 million for delivery on day D—the BIS sets EIBOR as the day D overnight interest rate. If the ECU banking system is in an aggregate net short position in ECU exchanged for component currencies exceeding ECU 100 million in value, the BIS sets EIBID as the day D overnight interest rate. Otherwise, it sets the overnight interest rate at the arithmetic mean between EIBOR and EIBID.

Fixing the overnight rates effectively fixes $i(T)_{ECU}$ in equation (9) through the term structure[28] and makes $S(0)_{ECU}/B(0)_{DM}$ a determinate function of the present and future underlying Basket composition, cross-currency exchange rates, individual currency overnight interest rates, and the BIS's weighing scheme for fixing the interbank ECU rates.

Equilibrating Properties of the Interest Rate Setting Rule

Since EIBOR always exceeds EIBID, this interest rate setting rule has certain equilibrating properties. For example, if the banking system moves from an aggregate flow long to an aggregate flow short position in the ECU exchange market, the selling of ECU by the banking system results in a reduction of Basket deposit liabilities and an equivalent increase in ECU deposit liabilities held by the nonbank sector. This expansion of demand for ECU deposits triggers a decrease in the overnight rate from EIBOR to EIBID and a fall in the deposit rate. From equation (9), such a change from EIBOR to EIBID in the overnight rate has the effect of depreciating the ECU against the Basket. If the market anticipates a permanent *short* ECU position for the banking sector, so that the lower overnight rate will continue to apply, then this would be reflected in the entire ECU interest rate term structure and the depreciation would be more marked. Such a depreciation and lower yields relative to the Basket would tend to reduce the private demand for ECU deposits.[29]

[28] For example, in the simplest case, if the expectations hypothesis of the term structure is valid, $i(t)_{ECU}$ is the arithmetic average of future expected bank ECU tomorrow/next rates through time t. More generally, the expectations hypothesis yield would be adjusted by liquidity premiums and discounts.

[29] The equilibrating features of this rule for the setting of the overnight interest rate apply only to the flow disequilibrium in the exchange market during the day. It is likely that there will be occasions when the banking sector has a positive net asset position in ECU while there exists an excess supply of ECU in the exchange market.

Arbitrariness of the Interest Rate Setting Rule

The choice of the rule for setting the ECU interest rate is arbitrary, in the sense that any rule would result in an equilibrium ECU/Basket exchange rate. As an example of the arbitrariness in the choice of the bank ECU own interest rate, suppose that the BIS's current method of setting interest rates in overnight bank ECU loans generates an interest rate of 7 percent for bank ECU deposits maturing at time t. This would result in an $i(t)_{ECU}$ equal to 1.07. This establishes a spot exchange rate between bank ECU and DM of

$$S(0)_{ECU} = i(t)_{ECU} E[e(t) \cdot W(t)]/i(t)_{DM}$$
$$= 1.07 E[e(t) \cdot W(t)]/i(t)_{DM}. \quad (10)$$

Suppose that today the EBA and the BIS suddenly decide permanently to calculate the overnight bank ECU rate by multiplying its previous calculation by two. This would also double the interest rates in the rest of the term structure, changing $i(t)_{ECU}$ to 1.14, and increasing $S(0)_{ECU}$ by 6.5 percent. Note that the time t expected DM value of the bank ECU is unchanged in this exercise. The increase in the bank ECU own interest rate increases the amount of DM equivalent that a depositor expects to have at time t. Therefore, a depositor will pay more DM now for a bank ECU.

For any bank whose ECU position is balanced, it does not matter what own rate is established by the BIS for interbank overnight loans. The choice affects only the bank ECU spot exchange rate. For a borrower or lender with an unbalanced ECU position, however, such shifts in convention would create an exchange risk.

Some Alternative Approaches

Recent ECU research efforts have relied either on observed shifts in the flow demand and flow supply for ECU-denominated bank assets and liabilities or on market imperfections to explain simultaneously historical deviations from parity of the ECU/Basket exchange rate and the deviations of the ECU yields from the synthetic Basket yields.[30]

The demand and supply arguments consider two scenarios. In the first scenario, the ECU assets of the banking sector grow faster than its ECU

[30]See, for example, Girard and Steinherr (1989); Louw (1991) and (1992); Bishop (1991b); EBA (1991); or Lund (1991b).

Table 1. *Size of ECU Banking Market*
(Billions of ECU)

	1985	1986	1987	1988	1989	1990	1991	March 1992
Total ECU bank assets	63.9	70.3	80.7	100.6	128.2	148.6	194.0	196.4
Interbank	49.7	53.8	59.2	74.2	97.4	114.3	133.0	136.1
Non-interbank	14.2	16.5	21.5	26.4	30.8	34.3	61.1	60.3
Total ECU bank liabilities	58.1	60.4	66.5	88.3	116.9	149.8	193.1	202.6
Interbank	49.7	52.9	57.2	75.5	92.4	118.2	152.8	158.2
Non-interbank (including official deposits)	8.4	7.5	9.3	12.8	24.5	31.6	40.3	44.4
ECU net bank assets	5.8	9.9	14.2	12.3	11.3	−1.2	0.9	−6.3
Interbank	.0	0.9	2.0	−1.3	5.0	−3.9	−19.8	−22.2
Other	5.8	9.0	12.2	13.6	6.3	2.7	20.8	15.9
$US per ECU	0.888	1.070	1.303	1.173	1.197	1.363	1.341	1.244

Source: *International Financial Statistics*; Louw (1992).

liabilities. This occurred from 1985 through 1987, as indicated in Table 1. The small group of core ECU banks willing to run net positions in ECU will lend ECU to the rest of the banking system while funding themselves by selling Basket liabilities. The yield at which the core banks are prepared to lend ECU to the rest of the ECU banking system must exceed the yield they pay on their Basket liabilities.[31] Thus, during such periods the ECU yield will exceed the synthetic Basket yield.[32]

It is also correctly noted that in this scenario, where total bank ECU assets rise faster than bank ECU deposits, the nonbank sector recipient of ECU bank credit must also be a net seller of ECU against currency on the ECU/Basket exchange market. Hence, the core bank becomes a net buyer of ECU and a net seller of the Basket. Thus it is concluded that the ECU should be at a discount against the Basket.

In the second scenario, which prevailed between 1988 and the end of 1991 as indicated in Table 1, the ECU liabilities of the banking system grow faster than its ECU assets. Core ECU banks borrow ECU deposits from the rest of the ECU banking system, and lend Baskets of deposits of the currencies. Thus ECU yields will be below Basket yields. Furthermore, in this scenario the nonbank sector is a net ECU buyer on the ECU/Basket exchange market, rather than a net ECU seller, as in the previous scenario. The core banks sell ECU to the other ECU banks against the Basket. Hence, the ECU/Basket exchange rate should show a premium in favor of the ECU.

Notwithstanding these arguments, this literature suffers from the shortcoming of trying to explain movements in the ECU/Basket exchange rate *and* in the ECU interest rates with recourse to only one equation—the interest parity condition. To see this, let i_b be the Basket interest rate; i_{ECU}, the ECU interest rate; $x = B(t)_{DM}/S(t)_{ECU}$, the ECU/Basket exchange rate (ECU per Basket) at time t; and Ex, the expected future ECU/Basket exchange rate. Then

$$1 + i_b = x(1 + i_{ECU})/Ex \tag{11}$$

is a simplified version of the uncovered interest parity condition in equation (9). The observed interest phenomenon $i_b < i_{ECU}$ is associated with

[31] Indeed, the rule for setting the interest rate for overnight loans engendered in the clearing operation emerged from the notion that the Basket and the ECU were the same. If the two units were the same, there was a need to give a markup to the core banks in the exchange market when they were buying in ECU, relending the ECU overnight to the net debit banks, and funding the acquisition with Baskets; hence, the interest rate rule prescribed that they charge the offer rate on overnight lending in the Basket currencies.

[32] In other words, when ECU bank assets exceed ECU bank liabilities, then the marginal funding cost for ECU assets is the Basket interest rate.

flow borrowing of Baskets and flow lending of ECUs by the banking sector. This portfolio behavior of the banking sector is consistent with the usual arbitrage activities that bring about the interest parity result; that is, if $i_b < i_{ECU}$ then the arbitrating bank will sell Basket liabilities and buy ECU assets until $i_b = i_{ECU}$, providing that $x = Ex = 1$. The observed exchange rate phenomenon $x > 1$ is associated with the selling of Basket liabilities and the buying of ECU assets. Again, this behavior is the result of arbitrage supporting the interest parity until $i_b = i_{ECU}$ and $Ex = 1$. While the explanation for the movement in ECU interest rates and the explanation for the movement in the ECU/Basket exchange rate are each consistent with maintaining the interest parity condition, they cannot determine both variables—ECU/Basket exchange rate and ECU interest rate—simultaneously.

The approach taken in the literature falls short in two ways. First, it fails to recognize that *current* institutional arrangements in the private ECU markets alone are not sufficient to establish a determinate real value for the private ECU. Second, even if there is a recognition that an anticipated future pegging of the private ECU to the Basket affects the ECU/Basket exchange rate today, in light of the parity condition (6) or (9), this would only determine a relation between the ECU/Basket exchange rate and the ECU interest rate.[33] To obtain the ECU/Basket exchange rate, it is still necessary to identify the mechanism that exogenously sets the interest rate on the private ECU. Although the demand and supply approach reviewed above appears to produce independent conclusions about the movement of ECU yield and the ECU exchange rate, these are only two different ways of expressing the same phenomenon: the movement of interest rates and spot exchange rates as constrained by the interest parity equation.

IV. Deviations of the Private ECU/Basket Exchange Rate from Parity and of the Private ECU Yields from Synthetic Basket Yields

The previous two sections showed that expectations regarding the future pegging of the ECU/Basket exchange rate combined with an interest rate setting mechanism has taken the place of the traditional

[33] Lund (1991a) explicitly recognizes that expectations about a future pegging of the ECU rate influence the pricing of the ECU today. But he relies on the demand/supply argument to explain immediate fluctuations in the ECU/Basket exchange rate.

monetary control mechanism in determining the ECU/Basket exchange rate and positioning the ECU yield curve. In this section we explore the sources of volatility in the exchange rate and yields.

Spread between ECU Interest Rates and Synthetic Rates

We showed in the previous section that the ECU overnight interest rate is set by the BIS as EIBID or EIBOR depending on whether there is excess supply or excess demand in the ECU/Basket exchange market. Thus, a change in market conditions in the ECU/Basket exchange market will move the ECU overnight rate by the spread between EIBID and EIBOR, or by about 25 to 35 basis points, and a sustained change in the ECU/Basket exchange market conditions will shift the term structure by the bid-ask spread. These changes will then also appear as changes in the spread between ECU interest rates and synthetic rates. Hence, developments in EU money markets and in the ECU/Basket exchange market determine the short ECU interest rates and the premium/discount against the Basket. Knowledge of $D - 1$ tomorrow/next Euro-deposit rates in national currencies and knowledge of the demand and supply imbalance in the ECU bank market on $D - 2$ implies knowledge of the ECU rate for overnight loans from D to $D + 1$.

Moreover, divergences of the ECU term structure from the synthetic term structure are also due to uncertainty regarding future reconstitutions of the Basket,[34] greater liquidity of the ECU than some constituent currencies, anticipated shifts in the overnight interest rate setting convention, and differential tax treatment. Also, one clause in most ECU security prospectuses prescribes that the security will pay in Baskets if the EU ceases to use the ECU. Fluctuating probabilities of these events also affect the deviation from Basket rates.

Deviations of the ECU/Basket Exchange Rate from Parity

Once the term structure of ECU interest rates has been determined, then expectations concerning the future value of the ECU—the term $E[e(T) \cdot W(T)]$ in equation (9)—determine the spot ECU/Basket exchange rate. Three sources of uncertainty affect the future value of the private ECU: the composition of the Basket at the time of the fixing; the

[34] See Girard and Steinherr (1989).

future bilateral spot exchange rates; and the timing of the future pegging of the ECU to the Basket.

Before the recent attacks on the ERM, the first and second type of uncertainty were to some extent limited by the existing institutional arrangements. In particular, as long as the ERM was in effect, movements in spot exchange rates were limited to less than 6 percent against any member currency, unless there was a realignment; and the composition of the Basket was not likely to change radically. Since the widening of the ERM bands to 15 percent above or below central parities, this uncertainty has increased dramatically. The uncertainty surrounding the timing of the fixing has been reduced through the ratification of the Maastricht Treaty, but the timing now hinges on a set of countries' meeting the convergence criteria.

The ECU/Basket exchange rate will also be affected by changes in risk regarding its future DM value. Greater risk will increase the risk-adjusted DM discount rate and cause a depreciation of the ECU against the Basket. Changes in the expected composition and in future spot exchange rates will also result in changes in the ECU/Basket exchange rate. If weights are expected to remain constant ($W(0) = W(t)$), then the ECU can be perfectly hedged in DM at predetermined forward exchange rates.

Uncertainty regarding the future fixing itself will be reflected in the expectations about the future value of the ECU. This has potentially the largest effect on the exchange rate. Doubts about a successful outcome of the current efforts to move to Stage III of EMU will be translated into a lower expected value of the ECU and into a discount against the Basket. It is important to note that it is unlikely that a single country or a subset of the EU member states would want to accept the monetary implications of fixing the ECU/Basket exchange rate in the absence of an EC-wide agreement.

V. Summary and Conclusion

Since November 1988, there has been no official or private institutional arrangement or commitment to exchange private ECU for the official ECU/Basket at par. Instead, the private ECU/Basket exchange rate has fluctuated freely, with the private ECU trading at times at a premium of up to 100 basis points or at a discount in excess of 200 basis points against the Basket. The value of ECU-denominated financial assets (in excess of ECU 250 billion) is uncertain not only in terms of single currencies but also in terms of the Basket. Since the traditional monetary mechanism that gives real value to a currency has not yet evolved for the private ECU, the real value of the private ECU—the value of the private ECU

in terms of the Basket—has been determined by the market's expectations about a future fixing of the ECU/Basket exchange rate in the context of EMU. An interest parity condition, based on the expectations regarding the future fixing of the ECU's value, then determines possible combinations of ECU/Basket exchange rates and ECU interest rates. The ECU term structure in turn is tied down exogenously by the BIS as part of the private ECU payments clearing mechanism.[35] In particular, the BIS sets the overnight rate as a weighted average of overnight rates in constituent currencies. The term structure and the expectations regarding a future fixing of the exchange rate are then combined in the interest parity condition to yield the current ECU/Basket exchange rate. The currently available theoretical and statistical literature on the formation of expectations, the term structure of interest rates, and risk premiums in forward foreign exchange markets can now readily be applied to develop a quantitative approach to the pricing of ECU-denominated assets.

Fluctuations in the ECU/Basket exchange rate are partly due to changing expectations regarding the future fixing, that is, regarding the progress toward EMU. In addition, changes in bilateral exchange rates of currencies in the Basket and the composition of the Basket will impact on the ECU/Basket exchange rate. Hence, any uncertainty concerning the creation of a single European currency translates directly into exchange rate uncertainty for the private ECU.

Although this analysis has been based on the private ECU, it is readily applicable to the problem of determining the exchange rate of any other privately created composite currency in the absence of intervention to require or engage in exchange at par with its namesake basket. A mechanism to fix an interest rate and an expectation of future fixing of the exchange rate are sufficient conditions.

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[35] We emphasize that the combination of the interest parity condition with the exogenous setting of the ECU interest rate is a *sufficient* condition for making the exchange rate determinate. McCallum (1992), in commenting on an earlier version of this paper, argues that the interest rate setting mechanism used by the BIS is a lagged endogenous variable because it depends on flows in the exchange market two days prior to a day's clearing. Using a model in which the overnight rate is a lagged endogenous variable (although not identical to the BIS's rate mechanism) McCallum shows that a determinate exchange rate solution can emerge.

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Supply-Side Effects of Disinflation Programs

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This paper focuses on the short- and long-run supply-side effects of disinflation programs in a two-sector economy. Fixing the exchange rate reduces the wedge between the return on foreign assets and that on domestic capital, leading to an increase in the latter. After an initial real exchange rate appreciation and increase in the production of nontradables—resulting from a consumption boom—the new capital is gradually installed in the tradable sector. During this transitional period, further real appreciation takes place—as the expansion of the tradable sector pulls labor away from the nontradable sector—together with investment-driven deficits in the current account. We conclude that when appreciation and deficits are due to supply-side rigidities, rather than to credibility and/or price stickiness, no further policies (e.g., capital controls, incomes policies) are advisable. [JEL F41]

THIS PAPER focuses on the supply-side effects of disinflation programs, an aspect of these programs that has been largely neglected in the literature. The dynamic effects on several macroeconomic variables, generated by a disinflation program that permanently—and credibly—reduces the rate of devaluation, are studied in the context of a two-sector economy. Fixing the nominal exchange rate will be a particular case of our analysis, one of special interest given the renewed attention on currency boards as a stabilization instrument. Although we motivate our results with reference to some Latin American countries' programs, the

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introduction of supply-side factors "is bound to be particularly useful in understanding stabilization programs in Eastern Europe and the former Soviet Union where high inflation and structural changes are likely to coexist in the foreseeable future" (Végh (1992), p. 669).

The main stylized facts from disinflation programs in chronic inflation countries are sustained real appreciations of the domestic currency and cumulative current account deficits (Végh (1992)). Most explanations for these facts have relied upon the existence of backward-looking price-setting behavior (Rodriguez (1982), Dornbusch (1982), and Calvo and Végh (1994b)), credibility problems (Calvo (1986), Calvo and Végh (1993)) or gradual reductions in the rate of devaluation (Obstfeld (1985), and Roldós (1993)). Furthermore, with the exception of Roldós (1993), output in these papers is demand determined. In this paper, we show that those stylized facts can be obtained in a framework with market clearing, rational expectations, no credibility problems, and without the extrinsic dynamics of gradual programs. Our analysis shares some of the features of the models simulated by Rebelo (1993) and Uribe-Echevarria (1993) but, unlike these papers, the results are obtained analytically and using different production and accumulation structures.

Some evidence on these supply-side effects from the Argentine and Mexican stabilization programs is presented in Table 1. Both programs seem to have achieved a reasonable degree of credibility and fiscal consolidation fairly soon after their inception. The first two columns reflect the above-mentioned stylized facts of real exchange rate appreciation and current account deficits. The third column shows a remarkable (at least fourfold) increase in imports of capital goods, the driving force of those stylized facts in the model that we study. In a recent and comprehensive study, Fischer (1993) presents evidence of the negative effect that inflation has on growth and, in particular, on capital formation. By exploiting both cross-section and time-series data, the study suggests that this negative effect of inflation is not restricted to the long run, but that it also applies to the transitional periods that are the subject of our paper. The final column of Table 1 indicates a steady increase in labor force participation and hence in labor supply. Broader evidence on this issue is mixed: Cooley and Hansen (1989) find a negative correlation between the employment ratio and inflation for a sample of 23 countries during 1976–85, but De Gregorio (1993) finds a negative but statistically insignificant effect for 12 Latin American countries between 1950 and 1985.

This paper studies the short-run and transitional dynamics of a dependent-economy model in which inflation negatively affects the capital stock in the long run. When money is required to buy consumption as well

Table 1. *Disinflation: External Variables and Factor Supplies*

Year	Real exchange rate (index: 1980 = 100)	Current account (mill. of US$)	Imports of capital goods (mill. of US$)	Labor force participation (percentage)
		Argentina		
1987	40.9	−4,235	973	38.9
1988	37.4	−1,572	847	38.9
1989	32.7	−1,305	717	39.3
1990	48.7	4,552	618	38.7
1991	66.3	−647	1,637	39.2
1992	75.4	−6,546	3,872	39.7
1993	82.5	−7,452	6,924	40.7
		Mexico		
1987	55.6	4,247	2,631	...
1988	68.7	−2,374	4,027	51.6
1989	73.8	−5,825	4,769	51.8
1990	75.4	−7,451	6,789	51.8
1991	83.6	−14,881	8,588	53.3
1992	89.8	−24,806	11,556	53.9
1993	96.5	−23,391	11,056	55.1*

* Preliminary

Sources: IMF data; *International Financial Statistics*; Central Bank of Argentina and National Institute of Statistics; Bank of Mexico and National Institute of Statistics.

as capital goods, Stockman (1981) has shown that, contrary to the Mundell-Tobin effect, inflation reduces the steady-state level of the capital stock. In two-sector versions of that cash-in-advance model, it has been shown that inflation can have long-run effects on the pattern of trade as well as on the distribution of income (see Stockman (1985) and Roldós (1992)). Those papers, however, study only the long-run effects of inflation and do not allow for trade in foreign assets, precluding the analysis of the transitional dynamics of the real exchange rate and the current account. It is well known that the dynamics of the one-sector closed economy version of the cash-in-advance model are fairly involved (Abel (1985)). To overcome this problem, which is compounded by the two-sector nature of our model, the continuous-time cash-in-advance constraint popularized by Feenstra (1985) and Calvo (1986) is extended to include purchases of capital goods.

We consider an economy that produces and consumes a tradable and a nontradable good. The tradable good is produced using reproducible capital and labor, whereas the nontradable uses land (i.e., nonrepro-

ducible capital) and labor. This asymmetry in the reproducibility of the specific factors is introduced not only for tractability reasons but also to reflect the slower medium-run response of the supply of nontradables. Indeed, the supply of nontradables increases right after the fixing of the exchange rate, owing to a shift in labor supply toward that sector. However, in the medium run the tradable sector responds more flexibly through the importation of machinery and equipment relative to a nontradable sector that requires relatively more investment in infrastructure.[1]

In this framework, inflation generates a wedge between the real return of foreign assets and that of domestic assets—money, capital, and land—because of the cash-in-advance constraint. Fixing the nominal exchange rate reduces this wedge and leads to a higher desired capital stock. On impact the capital stock is fixed, but an increase in aggregate demand causes a real exchange rate appreciation, an expansion in the production of nontradables, and a boom in land prices.[2] As the new capital is installed it attracts labor away from the nontradable sector, leading to further real exchange rate appreciation. The consumption and investment booms lead to a deficit in the current account of the balance of payments, which is gradually reduced as the production of tradables grows over time. It is worth noting that over the medium run the economy experiences a persistent real exchange rate appreciation together with an improvement in the trade balance. This suggests that commonly held notions of competitiveness and sustainability of external deficits may be misleading.

This paper also discusses the impact of the disinflation program on real wages and labor supply. Though real wages are likely to fall during the early stages of the disinflation program, they increase in the transition to the new steady state. In contrast with the persistent increase in labor supply that one would observe in a gradual disinflation experiment (Roldós (1993)), the response here is ambiguous. On the one hand, the reduction in the monetary wedge leads to an increase in the supply of labor (as originally shown in Aschauer and Greenwood (1983)) as the income generated from work effort is no longer subject to the inflation tax. On the other hand, the wealth and intertemporal substitution effects (wages are higher in the future) tend to reduce the supply of labor. Despite the fact that there is some evidence of a positive response of

[1] Examples of the latter are the housing and retail sectors, public utilities, and services like health and education.

[2] Calvo (1983) presents a portfolio-balance model in which demand and supply functions are not derived from first principles. In his model, it is the increase in the price of land, owing to a portfolio shift, that leads to an increase in the demand for nontradables and a real appreciation. In our model, the increase in the demand for nontradables causes the real appreciation and this in turn leads to an increase in the price of land.

labor supply, it is unlikely that it would be strong enough to outweigh the effects due to capital formation.

When the real exchange rate appreciation and current account deficits result from credibility problems or price stickiness, capital controls and/or incomes policies may be used to attenuate those effects. Our analysis shows that when the rigidities come from the supply side, rather than from prices and/or expectations, those policy recommendations are unwarranted.

I. The Model

Consider a small open economy that produces and consumes tradable and nontradable goods. After the derivation of demand and supply functions from the optimizing behavior of consumers and firms, relative prices are determined from the equilibrium of goods, assets, and factor markets.

Supply

Consider a two-sector specific-factors model where the tradable good T is produced using capital K and labor L^T, while the nontradable good uses land N and labor L^N, according to the constant returns to scale production functions:

$$y^T = G(L^T,K) = K^{\beta}L^{T(1-\beta)} \tag{1}$$

and

$$y^N = F(L^N,N) = N^{\gamma}L^{N(1-\gamma)}. \tag{2}$$

The tradable good is also a capital good, but in order to invest it, installation or adjustment costs have to be incurred (as in Abel and Blanchard (1983)).[3] Without loss of generality, we assume the simplest quadratic adjustment cost technology, namely, that to invest I units of the tradable good one has to spend J units, where

$$J = I\left(1 + \frac{\phi}{2}\frac{I}{K}\right). \tag{3}$$

The relative price of the nontradable good in terms of the tradable good is defined as $p = p^N/p^T$. To maximize profits, firms hire labor up to the point where the value of the marginal product equals the wage rate w:

$$G_L(L^T,K) = w(K,p) = pF_L(L^N,N), \tag{4}$$

[3] A discussion on the restrictiveness of the production and accumulation assumptions is provided in Section IV.

which is a function of the capital stock and the relative price of nontradables, as are the rental on capital, r^K, and on land, r^N:

$$r^K(K,p) = G_K(L^T, K) \tag{5}$$

and

$$r^N(K,p) = pF_N(L^N, N). \tag{6}$$

From this optimal behavior, the supply functions for the representative firm in each sector follow:

$$y_t^T = \delta_T K_t [w(K_t,p_t)]^{(\beta-1)/\beta}; \; y_t^N = \delta_N N [p_t/w(K_t,p_t)]^{(1-\gamma)/\gamma}, \tag{7}$$

where δ_T and δ_N are constants. Features of these supply functions will be important for the dynamics of the real exchange rate and the current account.

Demand

The representative household in this economy derives utility from the flow of consumption of both tradable (c^T) and nontradable (c^N) goods over an infinite horizon. The instantaneous utility function is assumed to be a Cobb-Douglas function to simplify the dynamics of consumption and concentrate on the dynamics of investment and the capital stock. Aggregate welfare is then given by

$$U = \int_0^\infty [\nu \log c^T + (1-\nu)\log c^N] e^{-\rho t} dt. \tag{8}$$

The household is assumed to own both the tradable and nontradable firms. In order to purchase both consumption and capital, the household has to hold sufficient cash in advance of those purchases—that is, it is subject to the liquidity constraint

$$M_t \geq \alpha E_t (c_t^T + p_t c_t^N + J_t), \tag{9}$$

where E_t is the nominal exchange rate.[4] In this dynamic setup, capital and land are not only factors of production but also assets. In addition to those assets and money, individuals in this economy have access to an internationally traded bond whose rate of return in terms of the tradable good is r. Interest rate parity ensures that its nominal rate of return is $R = r + \pi$, where π equals the rate of devaluation. Hence, the budget constraint

$$\dot{B}_t = rB_t + y_t^T + p_t y_t^N + \tau_t - c_t^T - p_t c_t^N - J_t - R_t m_t \tag{10}$$

[4] This is a straightforward extension of the cash-in-advance constraint in Stockman (1981) to continuous time; for a rationalization along the lines of Feenstra (1985), see Roldós (1988).

shows the change in net foreign assets B as the difference between income (which includes government transfers τ) and absorption (including the opportunity cost of real cash balances m). The household maximizes utility (8) subject to the cash-in-advance constraint (9), the budget constraint (10), and the accumulation constraint

$$\dot{K}_t = I_t, \tag{11}$$

as well as the initial conditions $B_0 = B(0)$ and $K_0 = K(0)$. For simplicity, no depreciation is assumed.

The details of the solution of the optimization problem are discussed in the Appendix. We assume that the rate of time preference ρ equals the world interest rate r. This implies that the shadow value of foreign assets λ will always be at its steady state value, allowing us to concentrate on the dynamics of investment. From that solution we derive consumption functions for tradables and nontradables:

$$c^T(\lambda;\pi) = \frac{\nu}{\lambda(1+\alpha R)} \tag{12}$$

and

$$c^N(\lambda, p_t;\pi) = \frac{(1-\nu)}{\lambda(1+\alpha R)p_t}, \tag{13}$$

where the rate of devaluation π enters through the nominal interest rate of the monetary wedge $(1+\alpha R)$. They also satisfy the usual efficiency conditions, that is, that the marginal rate of substitution in consumption and the marginal rate of transformation in production equal the relative price:

$$\frac{(1-\nu)c^T}{\nu c^N} = p_t = \frac{G_L(L^T,K)}{F_L(L^N,N)}. \tag{14}$$

The investment function is derived from the condition that equates the marginal cost of investing to its marginal benefit. Investment is hence a function of Tobin's q,

$$I(K_t,q_t) = \frac{K}{\phi}(q_t - 1), \tag{15}$$

and of the capital stock. The parameter ϕ is an important determinant of the concavity of the technology of the tradable sector (see Roldós (1991) and Serven (1995)). It determines the degree of intertemporal substitution in production, that is, the response of investment to a given increase in the shadow value of capital. The latter is given by

$$q_s = \int_s^{\infty} \left[(1+\alpha R)^{-1} G_K(L_t^T, K_t) - \frac{\phi}{2}(I/K)^2\right] e^{-r(t-s)} ds, \tag{16}$$

where we can see how the rate of devaluation reduces the net marginal product of capital and leads to a lower capital stock (as in Stockman (1981 and 1985) and Roldós (1988 and 1992)). In those studies, however, the analysis is concerned only with steady-state comparative statics, as the dynamics are very complex for the discrete-time cash-in-advance constraint (see Abel (1985)). Our continuous-time version will allow us to study not only the steady-state impact of reductions in the rate of devaluation but also the dynamic evolution of the system.

Equilibrium

We have derived consumption and investment functions, which take as given the relative prices p_t and q_t. In a perfect foresight equilibrium, these prices have to be consistent with equilibrium in goods and factor markets.

Equilibrium in the labor market yields the usual expression for changes in the wage rate derived from the static specific factors model (Jones (1971); Mussa (1974)):

$$\hat{w} = \xi_p \hat{p} + \xi_k \hat{K}; \quad \xi_p = \frac{\lambda_N \eta_N}{\lambda_N \eta_N + \lambda_T \eta_T}, \quad \xi_k = \frac{\lambda_T}{\lambda_N \eta_N + \lambda_T \eta_T}, \tag{17}$$

where λ_i stands for the fraction of the labor force employed in sector $i = T, N$, η_i for the respective elasticity of labor demand, and a circumflex ($\hat{}$) over a variable denotes its rate of change. In our dynamic framework, however, the changes in p and K are endogenously determined.

Equilibrium in the nontradable sector requires

$$c^N(\lambda, p_t; \pi) = y^N(p_t, K_t). \tag{18}$$

Totally differentiating this expression, it follows that changes in the real exchange rate are directly related to those in the capital stock:

$$\hat{p} = \left[\frac{(1-\gamma)\,\xi_k}{\gamma - (1-\xi_p)(1-\gamma)}\right]\hat{K} = \Omega \hat{K}. \tag{19}$$

In the Appendix we show that the constant Ω is positive for reasonable parameter values.

To concentrate on the dynamics of stabilization, we assume that the government increases domestic credit at the same rate as the devaluation rate and that it redistributes back to consumers the proceeds of the inflation tax together with the interest from reserves h_t:

$$\tau_t = \pi_t m_t + r h_t. \tag{20}$$

The assumption of a smooth path for reserves ensures that the government does not violate its intertemporal budget constraint and that the

monetary terms cancel out in the aggregate budget constraint (see Obstfeld (1985)). Substituting these results and equation (20) into equation (10) we get a simpler expression for the current account:

$$\dot{B}_t = rB_t + y^T(p_t, K_t) - c^T(\lambda;\pi) - J(q_t, K_t), \tag{21}$$

which will be determined by the evolution of the capital stock and the relative prices p and q.

II. Steady State and Dynamics

The economy we study presents a very rich menu of assets (capital, land, money, and foreign bonds), which would suggest a complex dynamic behavior. It is straightforward to see, however, that the dynamics of the system are governed by the evolution of the capital stock and its shadow value. Equations (19) and (21) show that, once the general equilibrium features of the model are spelled out, the dynamics of the real exchange rate and the current account follow recursively from the dynamics of Tobin's q and the capital stock. The latter are given by the system

$$\dot{K}_t = \frac{K_t}{\phi}(q_t - 1) \tag{22}$$

$$\dot{q}_t = rq_t - \left[(1 + \alpha R)^{-1} r^K(K_t, p_t) + \frac{\phi}{2}(I_t/K_t)^2\right], \tag{23}$$

which can be linearized around the steady-state values $(\bar{K}, \bar{q})$ and put in matrix form:

$$\begin{bmatrix} \dot{K} \\ \dot{q} \end{bmatrix} = \begin{bmatrix} 0 & \frac{K}{\phi} \\ \frac{-r_K^K(K,p)}{(1+\alpha R)} & r \end{bmatrix} \begin{bmatrix} K - \bar{K} \\ q - \bar{q} \end{bmatrix}. \tag{24}$$

The determinant of this differential equation system is $D = (K/\phi)(\partial r^K/\partial K) + (\partial r^K/\partial p)(\partial p/\partial K)$, which is negative, thereby ensuring that the equilibrium is a saddlepoint. Given the initial value of the capital stock and no anticipated disturbances, the convergent trajectories of K and q are

$$K_t - \bar{K} = (K_0 - \bar{K})\, e^{\mu t} \text{ and} \tag{25}$$

$$q_t - \bar{q} = (\mu\phi/K)(K_0 - \bar{K})\, e^{\mu t}, \tag{26}$$

where μ is the (stable) negative root of the transition matrix. Inserting

these results into equation (19), we obtain the transitional equation for the real exchange rate

$$p_t - \bar{p} = \Omega(\bar{p}/\bar{K})(K_0 - \bar{K})\, e^{\mu t}. \tag{27}$$

The price of nontradables moves in the same direction as the capital stock along the convergent path to the steady state.[5] When the economy starts from a low level of capital, the expansion of the capital stock attracts labor away from the nontradable sector, leading to an increase in real wages together with a real exchange rate appreciation.

The dynamics of net foreign assets can be obtained by linearizing the expression for the current account:[6]

$$\dot{B}_t = r(B_t - \bar{B}) + (y_K^T - J_K)(K_t - \bar{K}) - J_q(q_t - \bar{q}). \tag{28}$$

Using previous results, we obtain the following differential equation:

$$\dot{B}_t = r(B_t - \bar{B}) + \Gamma(K_0 - \bar{K})\, e^{\mu t}, \tag{29}$$

where $\Gamma = (y_K^T - J_K - \mu)$ summarizes the impact of the evolution of K and p on the production of the tradable, net of investment spending; in the Appendix we show that Γ is positive for reasonable parameter values. The solution of equation (29) relates the evolution of net foreign assets to that of the capital stock:

$$B_t - \bar{B} = -\Gamma(r - \mu)^{-1}(K_0 - \bar{K})\, e^{\mu t}. \tag{30}$$

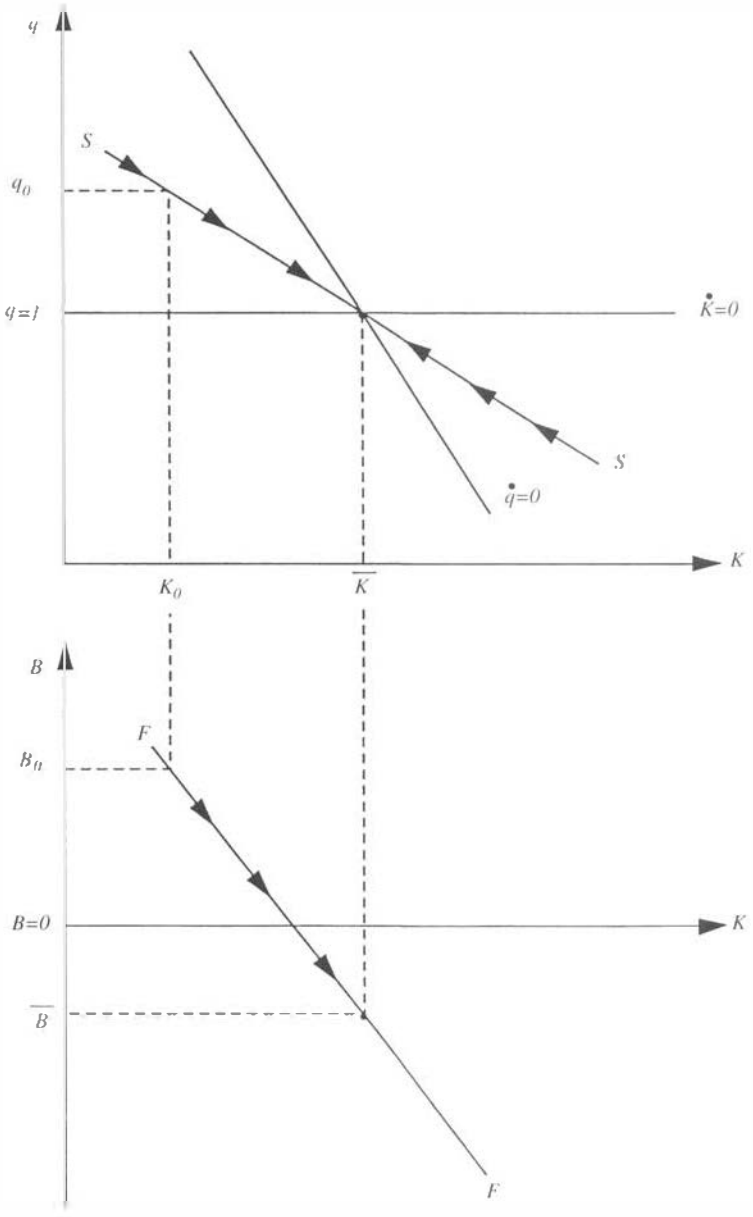
The increase in the capital stock is financed by a reduction in the level of net foreign assets, that is, by increases in external debt. The sustainability of the latter is guaranteed by the imposition of the usual transversality condition.

A graphical description of the model is given in Figure 1. The upper diagram shows the usual $\dot{q} = 0$ schedule, where the negative slope reflects the decline in the return to capital, owing not only to the increase in K but also to the appreciation of the real exchange rate. The stable adjustment path, SS, described by equation (26) has a negative slope determined largely by the adjustment cost parameter ϕ. The larger that

[5] Serven (1995) obtains the opposite relationship between capital accumulation and the real exchange rate. This is due to the existence of only one domestic good that faces a downward-sloping demand in world markets. Capital accumulation leads to an increase in its supply that can only be absorbed with a fall in its relative price.

[6] See Sen and Turnovsky (1989) and Serven (1995) for a similar strategy in one-sector models; the latter also imposes balanced private trade. Roldós (1991) solves for the path of net foreign assets in a two-sector model without linearizing the dynamic system.

Figure 1. *Dynamics of* K *and* B



parameter, the steeper the path, reflecting a lower degree of intertemporal substitution on the production side as well as a slower speed of adjustment toward the steady state—summarized by the negative root μ. The lower diagram describes the path of net foreign assets, FF, as a function of the capital stock (equation (30)), where the degree of concavity of the technology plays a similar role on the slope of the adjustment path.

In the steady state there are neither capital gains nor losses (i.e., $\dot{q} = 0$) and the stocks of capital and net foreign assets are constant (i.e., $\dot{K} = \dot{B} = 0$). This implies that the capital-labor ratio in the tradable sector is determined by the rate of devaluation and the rate of return on foreign assets,

$$G_K(L^T, \bar{K}) = r^K(\bar{p}, \bar{K}) = r(1 + \alpha R), \tag{31}$$

where we have used the fact that Tobin's q equals 1 in the steady state. From equations (10) and (21), total spending in the steady state has to equal interest earnings on total wealth:

$$\begin{aligned} c^T(\lambda; \pi) + \bar{p}c^N(\bar{p}, \lambda; \pi) &= r\bar{B} + y^T(\bar{p}, \bar{K}) + \bar{p}y^N(\bar{p}, \bar{K}) \\ &= r\bar{B} + r^K(\bar{p}, \bar{K})\bar{K} + r^N(\bar{p}, \bar{K})\bar{N} \\ &\quad + \bar{w}(\bar{p}, \bar{K})L, \end{aligned} \tag{32}$$

where the last three terms summarize the rentals from capital and land as well as wage income. As is well known (see Giavazzi and Wyplosz (1983)), in models that equate the rate of time preference to the world interest rate, the steady state—as well as the path that leads to it—depends on the dynamic characteristics of the model and the initial conditions. In particular, the rate at which capital is accumulated has permanent effects on the real exchange rate and the level of net foreign assets, as can be seen from equations (27) and (29). Inserting the initial condition for net foreign assets into equation (30) (see Sen and Turnovsky (1989) and Serven (1995)), we can obtain the steady-state level of net foreign assets,

$$\bar{B} = B_0 + \Gamma(r - \mu)(K_0 - \bar{K}), \tag{33}$$

as a function of the steady-state level of the capital stock. Substituting this result, together with the equilibrium condition in the nontradable good market and the efficiency conditions in equation (14), into equation (32), we obtain a simplified expression of the budget constraint

$$r\bar{B}(\bar{K}) + y^T(\bar{p}, \bar{K}) = \gamma(1 - \gamma)^{-1}\bar{p}y^N(\bar{p}, \bar{K}). \tag{34}$$

This expression and equation (31) are sufficient to calculate the steady-state levels of the capital stock and the real exchange rate.

III. Effects of a Permanent and Credible Disinflation

Most stabilization programs involve a reduction in the rate of devaluation, and sometimes fixing of the nominal exchange rate. The ensuing real exchange rate appreciation and trade deficits have been attributed to lack of credibility or backward-looking indexation (see Végh (1992)). In this section, we show how these stylized facts may appear as an equilibrium phenomenon, owing to the interaction of monetary and supply-side factors.

We study first the effects that a permanent and credible reduction in the rate of devaluation has on the steady-state or long-run values of the main variables. Second, we analyze the short-run effects as well as the transition toward the new steady state.

The Long Run

As was mentioned above, inflation acts as a tax on the return to domestic capital relative to foreign assets. A reduction in the rate of devaluation leads then to an increase in the capital-labor ratio in the tradable sector. Such an increase could result from either a rise in the capital stock or a shift in the allocation of labor toward the nontradable sector—which is likely, given the increase in the relative price of that good. We show in the Appendix that under fairly general conditions, both the capital stock and the relative price ofnontradables increase in the long run. The results are given by:

$$\frac{d\log K}{d\log(1+\alpha R)} = \left(\frac{-\Delta_L}{\Delta_K + \Delta_L}\right)\left(\frac{1+\beta}{1-\beta}\right) < 0, \tag{35}$$

$$\frac{d\log p}{d\log(1+\alpha R)} = -\left(\frac{\beta}{1-\beta}\right) - \gamma\left(\frac{\lambda_T}{\lambda_N}\right)\frac{(s-1)[\beta + \Gamma(r-\mu)^{-1}]}{(1-\beta)(\Delta_K + \Delta_L)} < 0, \tag{36}$$

and

$$\frac{d\log L^T}{d\log(1+\alpha R)} = \frac{(s-1)[\beta + \Gamma(r-\mu)^{-1}]}{(1-\beta)(\Delta_K + \Delta_L)} > 0, \tag{37}$$

where

$$s = \frac{y^T}{y^T + rB}; \quad \Delta_K = s\beta + (s-1)\Gamma(r-\mu)^{-1},$$

and

$$\Delta_L = s(1-\beta) + \left(\frac{\lambda_T}{\lambda_N}\right).$$

The parameter s is the ratio of the domestic production of tradables to the total supply of those goods. Since most chronic-inflation countries hold large external debts—so that B is negative and large—that ratio is greater than one, as assumed in equations (35) to (37). This is a sufficient condition to obtain an increase in the capital stock and in the relative price of nontradable goods—that is, a real exchange rate appreciation.[7] The importance of this parameter is related to the dual role of capital as an asset and as a factor of production. Inflation biases the portfolio of domestic residents away from domestic assets (money, capital, and land) and toward foreign assets. The smaller the share of the latter in the total portfolio, the larger the share of labor in the tradable sector (i.e., the supply of tradables comes more from domestic production than from the interest on net foreign assets). In these circumstances, a given increase in the capital stock leads to a strong increase in wages and a large real exchange rate appreciation.

If the country is neither a net creditor nor a net debtor (so that $s = 1$), the sectoral allocation of labor would remain the same as before the stabilization program was launched. The increase in labor demand in the nontradable sector—linked to the real appreciation—is exactly compensated by the increase in labor demand in the tradable sector—linked to capital formation. However, if the country was originally a net debtor, labor employed in the tradable sector falls (see equation (37)), which means that output of the nontradable increases. Production of tradables also increases, despite the fall in employment, owing to the higher capital stock. This is required to ensure the sustainability of the trade deficits incurred during the initial stages of the stabilization—see the discussion in the next section and Figure 3. From equation (32) one can infer that a higher level of consumption in the new steady state, together with a lower income from net foreign assets, requires more production of tradables.

Short-Run and Transitional Dynamics

The short-run effects of, and the transitional dynamics to, the new steady state are illustrated in Figures 2 and 3. On the one hand, neither the capital stock nor foreign assets can jump when the stabilization begins. On the other hand, both the shadow value of capital and that of

[7] Similar results were found in Roldós (1988). In that paper, however, there was no dynamic adjustment because the absence of adjustment costs implied an instantaneous exchange of foreign assets for capital.

Figure 2. *Permanent Stabilization*

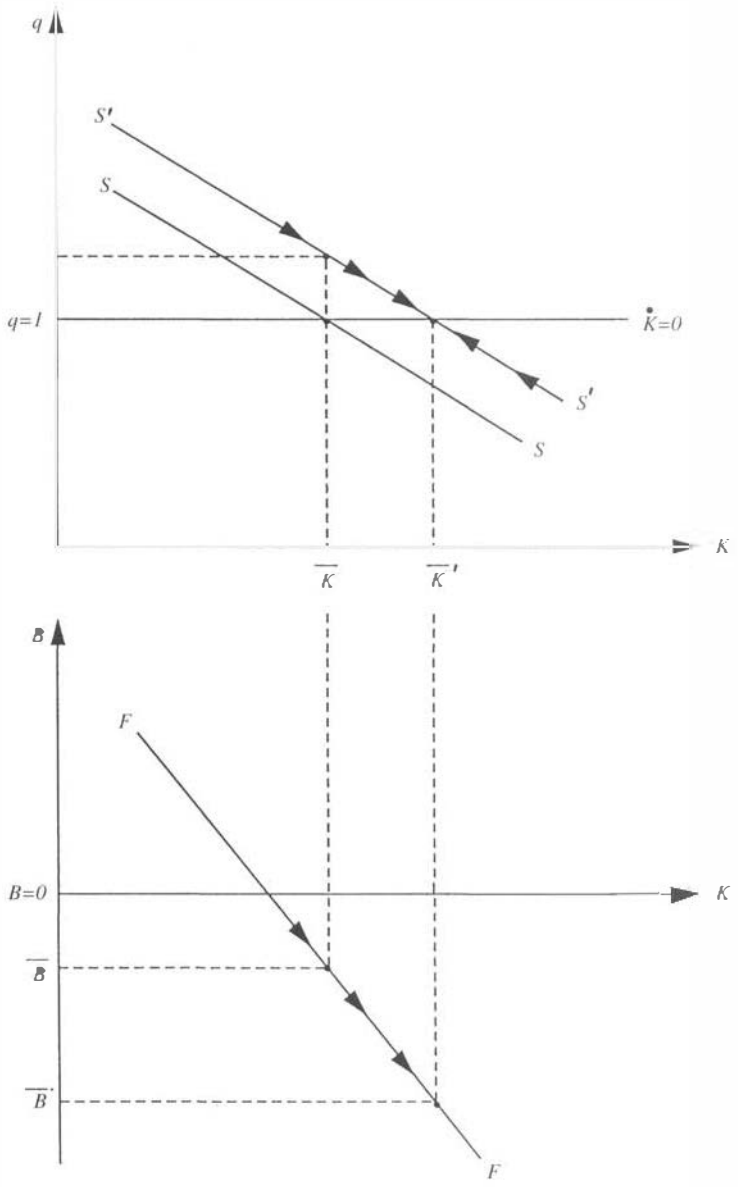
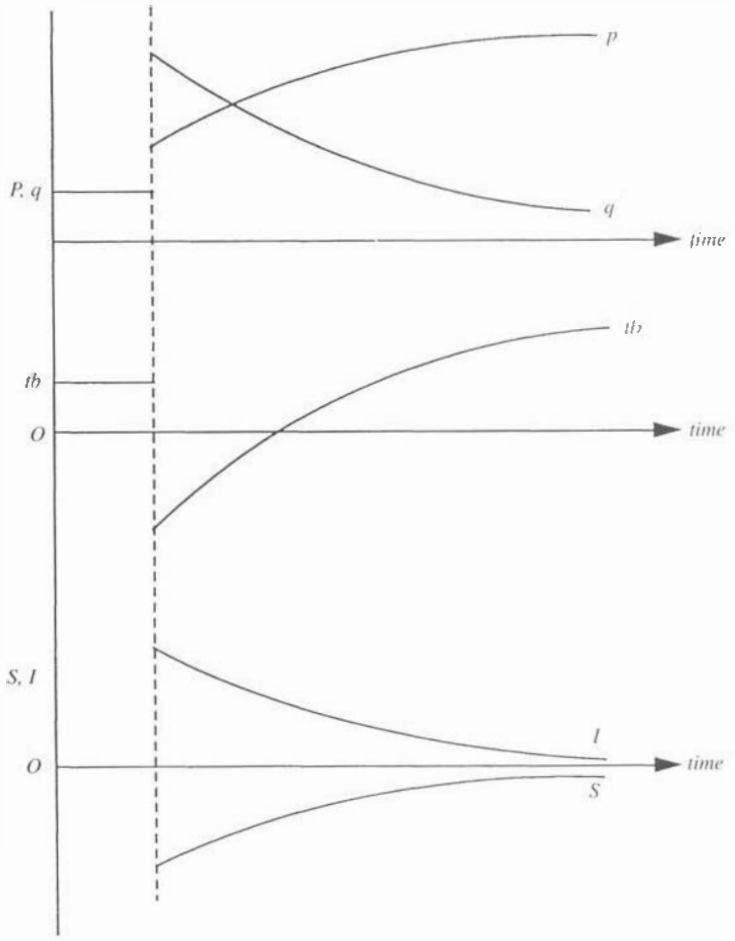


Figure 3. *Dynamics of Relative Prices and External Accounts*



foreign assets jump on impact, discounting all the effects of the reduction in the rate of devaluation.

The increase in the capital stock from $\bar{K}$ to $\bar{K}'$ guarantees that the $\dot{q} = 0$ schedule shifts up. A higher value of Tobin's q leads to an increase in investment, which is smoothed over time according to the value of the adjustment cost parameter ϕ (see equation (15)). This surge in investment is partially responsible for the deficit in the current account that is typical of the early stages of stabilization.

To derive the impact on savings, we have to determine the response of

the shadow value of foreign assets λ to the reduction in π. Even though the change in λ is ambiguous (see the Appendix), we can show that $\lambda(1 + \alpha R)$ falls, causing an increase in consumption of both goods (see equations (12) and (13)). The ensuing real exchange rate appreciation attracts labor away from the tradable sector, whose output falls until the new capital begins to be gradually installed. This fall in savings reinforces the increase in investment, leading to a further deficit in the current account. Both the increase in p and that of L^N cause land rents (see equation (6)) and the price of land to jump up.

During the transition to the new steady state, the new capital is gradually installed and the production of tradables recovers at the same pace as the capital stock expands. In the process, labor is now being pulled away from the nontradable sector, leading to further real exchange rate appreciation—as summarized in equation (27). It is worth noting that during this transition we observe an expansion of net exports in spite of the sustained real exchange rate appreciation (see Figure 3 for the time path of the trade balance, tb, saving, S, investment, I, and relative prices). The features of the production and accumulation structure that contribute to this result are further discussed in Section IV.

We can also derive the model's implications for real wages. On impact, we get the same result as in the traditional static specific-factors model (Jones (1971), Mussa (1974)), summarized in equation (17) for $\hat{K} = 0$. Wages increase in terms of tradables—the numeraire—but they decrease in terms of nontradables. The higher share of consumption of nontradables suggests the possibility of an initial fall in real wages (see Ruffin and Jones (1977)). However, once we allow for the endogenous increases in capital and in the relative price of nontradables, those results change. If we substitute equation (19) into equation (17), we can see that the evolution of wages is now

$$\hat{w} = \left(\xi_\rho + \frac{\gamma}{1-\gamma}\right)\hat{\rho}. \tag{38}$$

The term in brackets may or may not be greater than one, but it holds for a set of reasonable parameter values, as discussed in the Appendix. In that case, real wages increase unambiguously during the transition to the new steady state.

IV. Discussion, Extensions, and Policy Implications

In this section, we compare our results to those found in related literature, suggest some extensions to our work, and derive policy implications.

Related Literature

Calvo (1986) and Calvo and Végh (1993) study temporary reductions in the rate of devaluation as a modeling strategy for the lack of credibility that is usually present in the early stages of stabilization attempts in chronic-inflation countries. The temporary fall in prices vis-à-vis the future induces an intertemporal substitution in consumption toward the present, which leads to a real exchange rate appreciation and current account deficit. Both results are reversed when the stabilization is abandoned, with the real exchange rate depreciating even beyond its pre-stabilization level. Despite this being an attractive approach to study failed stabilizations, the quantitative relevance of the "temporariness" hypothesis has been questioned by Reinhart and Végh (1995). Given the relatively low elasticity of intertemporal substitution in consumption, nominal interest rates would have to fall substantially more than has been observed to account for a sizable fraction of the consumption boom experienced in several stabilization attempts.

Permanent and hence credible reductions in the rate of devaluation can lead to real exchange rate appreciation and current account deficits because of backward-looking behavior (Rodriguez (1982), Calvo and Végh (1994b)) or wealth effects (Helpman and Razin (1987), Calvo and Végh (1994a), De Gregorio, Guidotti, and Végh (1993) and Roldós (1993)). Calvo and Végh (1994b) question whether the initial expansion in aggregate demand is due to backward-looking price behavior, since this would require an intertemporal elasticity of substitution in consumption larger than that observed in most countries. Furthermore, they show that the result in Rodriguez (1982) is due not to the absence of rational expectations, but rather, to the lack of optimizing behavior.

The results in our model are also driven by a wealth effect, but one generated differently than suggested in the existing literature. In Helpman and Razin (1987), freezing the exchange rate provides the current generation with an intergenerational redistribution of wealth, through the benefits of an inflation tax cut. In Calvo and Végh (1994a), the reduction in the rate of devaluation reduces the amount of seigniorage paid abroad due to currency substitution. In our model, the reduction of the monetary wedge that disinflation generates leads to a higher net-of-inflation return on domestic assets. This leads to more capital formation and hence to a supply response that does not exist in the above-mentioned literature.

The Production and Accumulation Structures

Our model has two strong asymmetric assumptions: first, that capital is used only in the tradable sector, and second, that only the tradable goods can be accumulated. In this section, we show that the assumptions on the production structure are not crucial for the results, whereas those on the accumulation side are more critical—but have a plausible economic rationale.

Jones and Easton (1983) study a more general model that allows for the three factors to be mobile across both sectors. They reach the conclusion that: "the results of the sector-specific model lie in the "neutral" range of possibilities evident in the more general model, despite the strong asymmetric assumptions that extreme factors are used only in one industry. . ." (p. 96). Furthermore, the departures from this neutral case are only few and can be ruled out for standard assumptions on factor intensities across sectors. In particular, the conclusions of our model could be reversed if increases in the capital stock lead to a fall in output of the tradable sector, which, using Samuelson's reciprocity condition, implies that a real exchange rate appreciation leads to an increase in the return to capital:

$$\frac{\partial y^T}{\partial K} = \frac{\partial r^K}{\partial (1/p)} < 0. \tag{39}$$

This can be avoided by the following fairly general intensity assumptions

$$\frac{\theta_{KT}}{\theta_{KN}} > \frac{\theta_{LT}}{\theta_{LN}} > \frac{\theta_{NT}}{\theta_{NN}} \tag{40}$$

and/or

$$\frac{\theta_{KT}}{\theta_{KN}} > \frac{\theta_{NT}}{\theta_{NN}} > \frac{\theta_{LT}}{\theta_{LN}}, \tag{41}$$

where θ_{ij} stands for the share of factor i in good j, as well as with less intuitive factor substitutability assumptions (see Jones and Easton 1983)). It is reassuring that for equation (39) to hold when capital and land are good substitutes, it is also required that the share of labor in the tradable sector be larger than in the nontradable sector; international evidence seems to reject the latter requirement (see Kravis, Heston, and Summers (1983)).

When there are tradable and nontradable capital goods (see Brock and Turnovsky (1993) and Serven (1995)), an exercise like the one in this paper would yield a real exchange rate appreciation on impact, to be

followed by a depreciation thereafter (contrary to the persistent appreciations observed in the stabilization experiences). Uribe-Echevarria (1993) simulates a real-business-cycle model where investment goods are nontradable—though produced with a tradable component—and obtains the same pattern for the real exchange rate. He extends the initial real appreciation by adding gestation lags ("time-to-build") to the investment process. It is questionable whether both features belong in an investment technology, as they appear to be competing rather than complementary stories (see Kydland and Prescott (1982)). Furthermore, in the simulations, investment in the tradable sector does not recover to its initial level until after the real exchange rate begins to depreciate.

What is done in this paper amounts to assuming a differential supply response in the tradable sector vis-à-vis the nontradable sector. The former uses capital goods (say, machines and equipment) that can be easily obtained through trade, though the supply response is somewhat slowed down by the adjustment costs.[8] The nontradable sector uses capital goods (say, structures) that are more difficult to reproduce, and hence its medium-run supply response is much slower than that of the tradable sector. Our assumption of nonreproducible capital in the nontradable sector is an extreme case of a model where adjustment costs are larger than in the tradable sector. Finally, it would be straightforward to allow for the installation costs of the capital stock to be nontradable (as is done in Brock (1988) and Murphy (1989)), and our results would still be valid.[9]

Variable Labor Supply

So far, we have assumed that capital is the only factor of production that increases as a result of the reduction in inflation. However, it is well known that the labor supply would also be augmented as a result of disinflation (see Aschauer and Greenwood (1983), Stockman (1985)). If we include leisure, x, as a third argument in the utility function, i.e., $u = u(c^T, c^N, x)$ and we use subindices for the respective partial derivatives, we would obtain

$$u_1(\,.\,) = \lambda(1 + \alpha R) = (1 + \alpha R)\frac{u_3(\,.\,)}{w}. \tag{42}$$

[8] We are thinking here of the supply response of manufactures or nontraditional exports. As we discuss below, we interpret land broadly as capital that is slow to reproduce, probably also including infrastructure. Otherwise, the ranking of equation (40) would not be valid for natural resource exporters.

[9] Brock (1988) and Murphy (1989), however, make the strong assumption that there is no consumption of nontradables, and they discuss only fiscal policy issues.

We know from our previous discussion that the three terms have to fall, but that the net effect on λ is ambiguous. Assuming that λ does not change as a benchmark, the last equality implies that the ratio of the marginal utility of leisure to the wage would have to be constant. As wages increase on impact and during the transition to the new steady state (see equation (17)), leisure has to fall; that is, labor supply has to increase. These results hold for a separable utility function. Contrary to the case of a gradual reduction in the rate of devaluation (see Roldós (1993)), a high degree of intertemporal substitution tends to work against that direct increase in labor supply in the early stages of the disinflation program. The increase in labor supply would be concentrated more in the later stages, when wages are higher and hence the reward to work effort is larger. It is likely, however, that the direct effect mentioned above would yield some expansion of work effort throughout the stabilization, its magnitude being an empirical issue. Even if labor supply were to expand, it is unlikely that the increase would be large enough to reverse the real exchange rate appreciation.

Policy Implications

Whenever the lack of credibility of a disinflation program is modeled by a temporary reduction in the rate of devaluation, an intertemporal distortion is created. The imposition of capital controls is suggested in Calvo (1986) as a possible solution to that distortion, but not without caveats. Since credibility is exogenous in those models, it is not clear whether capital controls would actually increase the likelihood of success of the program. Agénor (1993) and Végh (1992) discuss alternative policies that might enhance the credibility of disinflation programs. An overly stringent fiscal stance and price and wage controls could have some impact on credibility but, again, the results are not clear cut.

The policy prescription from our model is that no other policy would be necessary: a gradual appreciation of the domestic currency and protracted current account deficits are the equilibrium response of the economic system once the supply side is given more structure and it is allowed to respond gradually over time. It is true that a fiscal balance was assumed throughout the paper for simplicity, but similar assumptions underlie the papers reviewed at the beginning of this section.

This is not to downplay the role that credibility issues and nominal rigidities might have in the early stages of disinflation. We do stress, however, that when chronic inflations are suddenly stopped there are factors that lead to the same "stylized facts" usually attributed to lack of cred-

ibility and price stickiness. And when the rigidities come from the slow response of the supply side, as opposed to when they come from prices and/or expectations, no further policy measures—like capital and/or price-wage controls—need be adopted.

APPENDIX

In this Appendix we discuss some of the more technical derivations that underlie the equations in the text.

Optimality Conditions

To solve the household's optimization problem we form the current value hamiltonian:

$$H(c_T, c_N, I, L_T; K_0, B_0) = [\nu \log c_t^T + (1 - \nu)\log c_t^N] + \lambda_t \left[rB_t + y_t^T + p_t y_t^N + \tau_t - (1 + \alpha R)\left(c_t^T + p_t c_t^N + I_t + \frac{\phi}{2}\frac{I^2}{K} \right) \right] + \lambda_t \theta_t I_t. \tag{A1}$$

The first order conditions are

$$\nu c^{T^{-1}} = \lambda(1 + \alpha R), \tag{A2}$$

$$(1 - \nu)c^{N^{-1}} = \lambda p(1 + \alpha R), \tag{A3}$$

$$\frac{\partial y^T}{\partial L^T} - p\frac{\partial y^N}{\partial L^N} = 0, \tag{A4}$$

$$(1 + \alpha R)[1 + \phi(I/K)] = \theta, \tag{A5}$$

$$-\lambda\left[\frac{\partial y^T}{\partial K} + (1 + \alpha R)\frac{\phi}{2}(I/K)^2\right] + \rho\lambda\theta = (\dot{\lambda}\theta), \text{ and} \tag{A6}$$

$$-\lambda\rho + \lambda r = \dot{\lambda}, \tag{A7}$$

to which we add the accumulation constraints (10) and (11) from the text, as well as the usual transversality conditions. From (A2) to (A4) we derive equation (14) in the text. Equation (15) follows from (A5) once we define $q = \theta(1 + \alpha R)^{-1}$. From (A6) we obtain the expression for Tobin's q.

Dynamics

The direction of the evolution of the real exchange rate as capital is accumulated is determined by the sign of Ω (see equation (19)). To study the determinants of that sign we rewrite Ω as

$$\Omega = \frac{\xi_k}{\dfrac{\gamma}{1-\gamma} - (1 - \xi_p)} = \frac{\xi_k}{\dfrac{\gamma}{1-\gamma} - \dfrac{\lambda_T/\beta}{\lambda_N/\gamma + \lambda_T/\beta}}. \tag{A8}$$

The stylized fact that the share of labor in nontradables is larger than that in tradables (Kravis, Heston, and Summers (1983)) implies that $\beta > \gamma$. When this is combined with the fact that the fraction of the labor force employed in the tradable sector tends to be smaller than the one employed in nontradables, it yields a strong presumption that Ω is positive for reasonable values of labor shares. In particular, if we take the average of the values calculated for Portugal by Rebelo (1993) and for Argentina by Uribe-Echevarria (1993), we obtain $\beta = 0.56$ and $\gamma = 0.32$. Combined with the value of $\lambda_N = 0.54$ presented by Rebelo, we obtain a value of $\Omega = 1.3$, which implies a 13 percent increase in the relative price of nontradables for every 10 percent increase in the capital stock.[10]

The sign of Γ is largely determined by that of y_K^T, since $J_K = 0$ around the steady state and μ is negative. A positive value of Γ implies that the increases in the capital stock are financed by borrowing abroad. A sufficient condition for this to happen is that y_K^T be positive. This would mean that as the capital stock expands, production of the tradable grows despite the fact that the ensuing real exchange rate appreciation pulls labor toward the nontradable sector. In formal terms:

$$\frac{dy^T}{dK} = \frac{\partial y^T}{\partial K} + \frac{\partial y^T}{\partial p}\frac{\partial p}{\partial K}$$

$$= \frac{y^T}{K}\left[1 - \left(\frac{1-\beta}{\beta}\right)\xi_k - \left(\frac{1-\beta}{\beta}\right)\xi_p \frac{(1-\gamma)\xi_k}{\gamma - (1-\xi_p)(1-\gamma)}\right], \tag{A9}$$

where the first term in the square brackets shows the direct effect of capital formation on the supply of tradables, and the other two represent the less-than-proportional increase of labor owing to the higher wages induced by more capital (the middle term) as well as by the increase in p (the last term). Simple manipulation of (A9) yields:

$$\frac{dy^T}{dK} = \frac{y^T}{K}\left\{1 - \left(\frac{1-\beta}{\beta}\right)\xi_k\left[1 + \frac{\xi_p}{\frac{\gamma}{1-\gamma} - (1-\xi_p)}\right]\right\}, \tag{A10}$$

where we can see in the last term how the same factors that we discussed for the sign of Ω apply for the sign of Γ. In particular, for the parameter values discussed above, Γ is positive.

Long-Run and Impact Effects

The steady state of the model can be summarized by equations (4), (31), and (34). Totally differentiating that system and using equations (7) and (33), we get

$$\hat{p} = [s\beta - (1-s)\Gamma(r-\mu)^{-1}]\hat{K} + [s(1-\beta) + (\lambda_T/\lambda_N)(1-\gamma)]\hat{L}^T$$

$$\hat{p} = -\gamma(\lambda_T/\lambda_N)\hat{L}^N - \left(\frac{\beta}{1-\beta}\right)(\hat{1} + \alpha R)$$

$$\hat{L}^T = \hat{K} + (1-\beta)^{-1}(\hat{1} + \alpha R). \tag{A11}$$

[10] Uribe-Echevarria does not present data on λ_N. From the OECD intersectoral database used in De Gregorio, Giovannini, and Wolf (1994), we calculated a value of 0.62 for the OECD countries in the period 1980–85.

Combining the first two equations, we obtain a system in $\hat{K}$ and $\hat{L}^T$ that yields the results in equations (35) to (37).

To get the initial jump in the real exchange rate, we exploit the fact that λ takes its new steady-state value on impact and stays there forever. Hence, we can differentiate equation (32) using equation (11) to get

$$d\log \lambda(1+\alpha R) = -d\log[r\bar{B} + y^T(\bar{K},\bar{p})] = \frac{\mu[\Gamma(r-\mu)^{-1}-1]}{r\bar{B} + y^T(\bar{K},\bar{p})} < 0, \quad \text{(A12)}$$

where we have used the fact that $\Gamma(r-\mu)^{-1} > 1$, owing to the adjustment costs (see Sen and Turnovsky (1989) and Roldós (1991)). Given that on impact K is fixed, from the condition of equilibrium in the nontradable market we get

$$d\log \lambda(1+\alpha R) = -[1 + (1/\gamma)(1-\gamma)(1-\xi_p)]\, d\log p < 0, \quad \text{(A13)}$$

which implies that p increases from the very beginning of the disinflation program.

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Shorter Papers

Establishing Monetary Control in Financial Systems with Insolvent Institutions

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The paper addresses the problem of establishing monetary control in financial systems with insolvent institutions. In particular, it examines the potential adverse selection, moral hazard, and collusion problems that can arise if indirect, auction-based monetary control systems are used in this environment. The analysis also considers the credit risks that can be assumed by the authorities when these market failures occur. The implications of using several alternative monetary control mechanisms, including a narrow banking system, the use of credit ceilings, and a two-tier banking system, are also examined. [JEL E52, E58]

COUNTRIES IN Eastern Europe and the former Soviet Union face the problem of establishing monetary control in order to foster noninflationary growth. It is widely recognized that the credibility of monetary control depends importantly on achieving fiscal control. Beyond ensuring fiscal discipline, however, establishing monetary control involves three basic considerations: selecting a nominal anchor—the exchange rate or some monetary or credit aggregate; establishing the rate of expansion for central bank domestic credit consistent with maintaining the nominal anchor; and determining the modalities for distributing central bank

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credit to the financial system. The first two considerations have received much attention in recent policy discussions. However, the advantages and disadvantages of different techniques for distributing central bank credit in a financial system dominated by insolvent institutions have received less attention; our paper will focus on this topic, particularly on the use of auctions of central bank credit.

In industrial countries, as well as in many developing countries, indirect monetary instruments encompassing discount window operations, advances, repurchase agreements, and open market operations are employed to alter the stock of central bank credit in the financial system. In market-based financial systems with solvent financial institutions that are subject to appropriate prudential supervision and market discipline, these indirect instruments provide a mechanism that both ensures an efficient distribution of credit and minimizes the credit risks that the central bank incurs. A key issue for countries making the transition from centrally planned to market economies is whether such techniques can be effective in financial systems dominated by insolvent financial and nonfinancial institutions.

The rest of this paper is divided into three sections. Section I examines the advantages of using indirect monetary policy instruments in market-based financial systems. Section II considers the adverse selection, moral hazard, and collusion problems that can arise when auction-based, indirect monetary policy instruments are used in transition economies. In Section III, we discuss alternative direct and indirect monetary policy instruments that can be used to establish monetary control for economies with financial systems dominated by insolvent institutions. The paper draws some conclusions in the final section, Section IV.[1]

I. Techniques for Establishing Monetary Control

In the early post-World War II period, monetary control in many industrial and developing countries was established through the use of direct monetary and credit instruments. Direct credit controls were particularly important during the reconstruction of Germany and Japan. These instruments typically involved the use of controls on interest rates (often with preferential interest rates for certain classes of borrowers),

[1] While the focus of this paper is on transition economies, many of the proposals advanced are equally relevant for developing countries that are in the process of moving to indirect monetary control.

aggregate and individual bank credit ceilings, credit allocation rules for financial institutions, and high required reserve and liquidity ratios. In financial systems that were dominated by commercial banks and closed to external financial transactions, such direct controls were seen as an effective means of influencing both the level of macroeconomic activity and the distribution of credit (Mathieson (1991)). However, as financial systems became more complex and open to international transactions, these instruments became increasingly difficult to administer effectively. Their macroeconomic effects also became less predictable as new financial institutions, instruments, and techniques created new avenues for the evasion and avoidance of direct controls. The monetary authorities in those countries therefore gradually moved toward monetary control systems based on indirect monetary instruments, both to overcome the shortcomings of direct instruments and to improve the efficiency of their financial systems.

While the relative importance of different types of indirect monetary instruments has differed across countries, there has been a trend toward using a combination of auction-based instruments and on-demand central bank facilities to meet both the short- and long-term liquidity needs of the financial system (Johnston and Brekk (1990) and Stigum (1983)). Auction-based instruments include, inter alia, open market purchases and sales of government securities, repurchase agreements, and foreign exchange operations. In auction-based operations, central bank credit is directed toward those market participants willing to pay the highest price.[2] On-demand facilities are typically focused on the central bank's discount window operations and advances. Such facilities often serve as a supplement to the central bank's auction-based operations, which are focused on satisfying the economy's general liquidity needs, and are used to meet the temporary liquidity needs of individual banks. In operating these facilities, the central bank usually specifies borrowing interest rates and establishes either explicit or implicit limits on access by individual banks to the facilities.

In designing auction-based operations and on-demand facilities, central banks try to ensure that they take onto their balance sheets only the most liquid and creditworthy instruments in the financial system. Open market operations usually involve transactions with either government or central bank securities, which presumably are regarded as carrying zero credit risk. Similarly, repurchase agreements often involve government securities. For discount window operations and advances, the authorities

[2] At times, central banks will accept less than the highest price in order to distribute open market operations across a dealer network.

typically define the set of eligible paper to be the commercial banks' most creditworthy, short-term instruments.[3] The creditworthiness of these instruments is judged at several levels. First, when the bank acquires the short-term paper that may eventually be used as collateral in its borrowing from the central bank's discount window, it must make a creditworthiness judgment about the corporate entity to which it is lending. In addition, in order for the bank to acquire these instruments, its depositors, owners, and creditors must also make a judgment that the bank is creditworthy or they would not provide the bank with the funds it needs for purchasing earning assets.[4] These private-sector creditworthiness judgments are supplemented by the authorities' prudential supervision, which is undertaken to help ensure that financial institutions are solvent and operating within established rules and procedures.

On the grounds of both efficiency and minimizing the credit risks that the central bank faces, indirect monetary instruments therefore offer an attractive means of establishing monetary control in economies with a broad range of financial structures. And, for economies making the transition from centrally planned to market-based systems, the establishment of monetary control systems based on indirect monetary instruments is clearly an appropriate medium-term objective.

Whether reliance on indirect monetary instruments in the short run is appropriate for economies in transition is a separate question. As indicated above, the attractiveness of indirect monetary instruments, especially those involving auction facilities, is based on the assumption that participants in the auction are solvent and subject to market discipline, as well as effective prudential supervision. Unfortunately, a significant proportion of the financial and nonfinancial institutions in transition economies are not subject to hard budget constraints, and there is often a weak system of prudential supervision and regulation.[5] This

[3] Even if a bank presents eligible paper, the central bank would still make an administrative judgment about whether the bank has already presented "too much" paper for discounting. If so, the central bank can refuse to discount more eligible paper for that bank.

[4] It is nonetheless well recognized that the presence of government guarantees such as deposit insurance or the belief that a financial institution will be assisted by the authorities because it is "too big to fail" can erode market discipline and distort creditworthiness evaluations.

[5] Perotti (1993) has characterized the financial systems of these economies as encompassing: state-owned banks with large holdings of nonperforming loans; new private banks, some of which have been set up by nonfinancial state-owned enterprises (SOEs) to obtain easier access to credit; weak systems of prudential supervision; poorly developed securities markets and nonbank financial intermediaries; many SOEs with weak financial positions and whose long-term solvency is questionable; and implicit or explicit deposit insurance guarantees.

raises the issue of what difficulties are likely to be encountered if the authorities should move rapidly to use auction-based indirect monetary policy instruments, as well as the steps that might be taken to minimize these difficulties.

II. The Use of Indirect Monetary Policy Instruments in Financial Systems with Insolvent Institutions

The use of indirect monetary policy instruments would appear to offer a number of advantages over the arbitrary and noneconomic criteria used to allocate credit by the central banks in most transition economies. For example, even though the scope for open market operations is limited by the size---or even the existence---of government securities markets, it has been suggested that central banks might use auctions to distribute planned increases in central bank credit to the financial system. Such auctions have been seen as introducing competitive market practices to both the central bank and other financial institutions; providing greater transparency regarding the authorities' criteria for allocating central bank credit; reducing wasteful, rent-seeking activities in the allocation of credit; directing credit toward the most efficient uses; and being consistent with the medium-term objective of establishing a monetary control system based on indirect monetary instruments (see Saal and Zamalloa (1995)). However, in order for credit auctions to provide these benefits, they must not expose the central bank to excessive credit risks because the financial system is dominated by insolvent institutions.

Feldman and Mehra (1993) and Guasch and Glaessner (1992) have analyzed alternative auction mechanisms and have indicated some of the potential problems that can arise, especially if some participants are insolvent or not subject to hard budget constraints. In considering when to establish credit auctions, Guasch and Glaessner (1992) concluded that auctions should be used when: there is significant evidence that current lending practices are not providing a fair and efficient allocation of credit; the competence and administrative capacity of supervisory agencies to monitor and assess the credit risk of potential participants can be assured; and competition exists, or can be induced, in the banking and financial sector. In addition, they argued that where state-owned banks are major participants, credit auctions are unlikely to be suitable until the banks are privatized. If these conditions are not satisfied, then the principal difficulties associated with credit auctions are *adverse selection and moral*

hazard problems,[6] both of which tend to raise real interest rates and credit risks, and *collusion* by oligopolistic borrowing institutions, which tends to result in low (possibly negative) real interest rates.[7]

Credit auctions in transitional economies can potentially give rise to significant adverse selection, moral hazard, and collusion problems because of the prevailing incentive structure. For example, state-owned enterprises (SOEs) that cannot cover their current operating costs through sales of output will have strong incentives to obtain credit to meet their working capital needs. In a stabilization program that sought to limit direct public credits to SOEs and the expansion of interenterprise arrears, SOEs would turn to the banks that had extended earlier credits for additional funds. Moreover, high borrowing costs would not necessarily deter borrowing by insolvent SOEs, especially if there is a past history of governmental assistance to troubled SOEs. The banks, in turn, would have strong incentives to supply additional credits in order to keep their borrowers afloat and avoid revealing the extent of their bad loans. If loans to insolvent SOEs constituted a significant proportion of a bank's portfolio,[8] then the need to supply additional credits to its troubled borrowers could provide the bank with an incentive to bid aggressively for either deposits from the public or central bank credits. In this situation, an *adverse selection* problem arises because credit is directed to the most risky borrowers and to the most risky projects.[9] If these adverse selection

[6] Adverse selection problems reflect the fact that auctions attract a high proportion of those institutions with the highest propensity to take risks, whereas moral hazard problems arise because of the inability of the lender (the auctioneer) to control or affect the usage of the funds by the borrowers. More generally, moral hazard problems in the financial system can arise whenever the owners, creditors, and depositors lack either the incentive (for example, if there is deposit insurance) or the ability (that is, because of poor disclosure requirements) to control the risk-taking activities of banks' managers.

[7] While it may be impossible to fully eliminate these problems, some steps can be taken to limit them, but each corrective step involves assessing tradeoffs. For example, adverse selection problems could be reduced by limiting participation in the auctions, but this could increase the possibility of collusion. Moreover, to control for the consequences of adverse selection and moral hazard, it may be necessary to place institution-specific caps on the amount of credit an institution can obtain, both at a single auction and cumulatively, but the process of determining these caps can reduce the transparency of the auctions. As a practical matter, the appropriate design of the auction necessarily involves evaluating the extent of the adverse selection, moral hazard, and collusion problems in each situation and employing those measures that will deal most effectively with the most pressing problems.

[8] A strong incentive for additional lending would naturally also exist if the troubled SOEs were also the principal owners of the bank.

[9] One potential indicator of such problems would be the emergence of very high real interest rates.

problems become significant, then solvent enterprises and new private firms will be excluded from the credit market by their unwillingness to pay the high interest rates that insolvent SOEs are willing to incur.

Moral hazard problems can arise if prudential supervision is weak and depositors have few incentives to monitor the lending activities of banks, such as would occur if depositors perceive that their deposits will be protected by implicit or explicit government deposit insurance.[10] In this situation, insolvent banks would increase their shares of central bank credit and total deposits by being willing to pay the high interest rates at central bank auctions and by offering higher deposit interest rates than could be paid by solvent financial institutions. Moreover, in systems with weak prudential supervision, the authorities may find it difficult to monitor bank activities and ensure compliance with prudential standards. Thus, with weak prudential supervision and limited market discipline, an auction-based monetary control system can lead to a perverse situation: insolvent institutions and enterprises have incentives to expand their operations at the expense of solvent ones.

Collusion problems can also arise from the strategic behavior of borrowers. As Perotti (1993) has noted, the close relationship between banks and SOEs has at times meant that, as credit conditions have been tightened, banks have created a "united front" with SOEs to lobby for a collective bailout through credit expansion by the central bank. In contrast to the effects of moral hazard and adverse selection problems, such collusive activities will tend to depress interest rates at central bank credit auctions and deposit interest rates and create pressures for a bailout of enterprise arrears.

When these problems of adverse selection, moral hazard, and collusion become severe, they can affect not only the distribution of central bank credit but also, importantly, the credit risks assumed by the central bank itself. For example, consider the situation in which the central bank has decided to auction domestic assets. A number of different auction arrangements could be used. One possibility would be for the central bank to auction credit to banks and accept claims on the individual banks with the highest bids. In a financial system dominated by insolvent

[10] As has been demonstrated in many industrial and developing countries, government deposit insurance guarantees can limit (or remove) the incentive for depositors to monitor a bank's loan portfolio and thereby eliminate an element of market discipline.

financial institutions, however, adverse selection and moral hazard problems would not only direct the central bank's credit toward the support of insolvent banks and their borrowers, but would also concentrate the highest credit risks in the financial system on the central bank's balance sheet. Even in the industrial countries where financial systems are dominated by solvent banks, the central banks seldom, if ever, accept direct claims on a bank precisely because of these credit risk considerations. As noted earlier, commercial bank borrowing from the central bank therefore takes place on a collateralized basis with the central bank accepting "eligible" paper as part of its discount operations or repurchase arrangements.

Consequently, it has been suggested that the credit risks assumed by the central banks in transition economies could be limited if credit auctions were done on a collateralized basis. An important issue is what "eligible" paper could serve as collateral. Eligible paper in the industrial countries typically consists of either short-term claims of banks on their most creditworthy borrowers or government securities. While the central bank in a transition economy could accept a bank's claims on an SOE, it might be very difficult to be confident that these were claims on a viable SOE. Indeed, many insolvent banks might hold little other than claims on insolvent enterprises. In this situation, auction transactions collateralized by claims on SOEs would do nothing to minimize the credit risks assumed by the central bank.

If auction transactions were collateralized by government securities, the credit risks assumed directly by the central bank would be minimized. However, there is still the question of whether the credit risks associated with insolvent banking institutions would be eliminated or merely transferred to another agency. In order for an insolvent bank to obtain the government securities that could serve as collateral for future borrowing from the central banks, it would have to offer a deposit interest rate that would attract new deposits. Thus, while the central bank would not necessarily take on new credit risks with collateralized auction techniques, the authorities would still be exposed to credit risks through explicit or implicit deposit insurance arrangements.

The credit risks assumed by the authorities can be of importance both because of the potential future budgetary obligations that can emerge in the case of eventual bank failures and because of the incentives that can be created for a more inflationary monetary policy that would erode the real value of the public sector funding obligation associated with deposit insurance or generate inflation tax revenues to cover the central bank's losses.

III. Alternative Arrangements for Establishing Monetary Control

A number of policy issues arise as a result of the market failures described above. First, if credit auctions are not employed, what alternative techniques for establishing monetary control can be used? Second, if auction-based monetary instruments are to be utilized, how can the auctions be structured so as to minimize the problems of adverse selection, moral hazard, and collusion? Several proposals have been put forth to answer these questions, and they draw on the recent experiences of a number of industrial and developing countries in dealing with insolvent, or nearly insolvent, institutions. In considering the relevance of the experiences of the industrial and developing countries for the problems confronting transition economies, however, it is clear that different "initial conditions" have faced these two sets of countries. The industrial and developing countries had market-based financial systems in which most, if not all, of the financial institutions were initially solvent. Their authorities were primarily concerned with the problems that arise as the financial positions of previously solvent institutions eroded. In contrast, the transition economies face the problems of dealing with financial systems that may be initially dominated by insolvent financial and nonfinancial institutions.[11]

While the authorities in countries with market-based financial systems have had the common medium-term objective of restructuring or closing insolvent financial institutions, there have been a variety of approaches to limiting the impact of these institutions on both the financial system and the authorities' ability to maintain monetary control. Nonetheless, there have been some common elements in all of these approaches. First, as the financial positions of solvent institutions eroded below established prudential supervisory norms, their activities became subject to increasingly restrictive administrative guidance. While the extent of such administrative guidance was typically addressed on a case-by-case basis, the procedures were formalized in established legal codes in some countries. Second, as the financial positions of supervised institutions deteriorated below acceptable regulatory norms, the authorities often took steps to limit or exclude the participation of these institutions in auction markets. In the United States, for example, the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) of 1989 excluded "trou-

[11] For Eastern Europe, Thorne (1993) estimated that at the end of 1991 nonperforming loans as a proportion of total bank lending ranged from 37 percent (in Romania) to 50 percent (in Hungary).

bled" institutions (that is, those that did not meet minimum risk-adjusted capital-asset ratios) from accepting brokered deposits, offering above-market deposit interest rates, or, in some cases, even expanding their lending activities or the acquisition of other assets. Finally, in order to help minimize the public sector funding obligations associated with the provision of deposit insurance, the authorities increasingly moved to merge, take control of, or dissolve troubled institutions *before* they became technically and legally insolvent (that is, before their net worth became zero or negative).

These prudential supervisory practices have been reflected in a number of proposals regarding reform of the financial systems in transaction economies (for example, see Begg and Portes (1992), Bredenkamp (1993), McKinnon (1991a and 1992b), Perotti (1993), and Rostowski (1994)). Since these proposals have attempted to identify the policies that would facilitate a transition from a centrally planned to a market-based financial system, they have addressed a much broader range of issues than those involved in establishing monetary control in financial systems dominated by insolvent institutions. Nevertheless, the proposals encompass a number of suggestions regarding the use of direct and indirect monetary policy instruments in transition economies. In the remainder of this section, we summarize the nature of these proposals, examine the rationales for the particular policies that have been recommended, and consider the advantages and disadvantages of utilizing the different monetary control mechanisms.

To address the adverse selection and moral hazard problems associated with financial transactions between insolvent financial institutions and nonfinancial enterprises, most proposals have focused on the use of: a narrow banking structure, direct monetary policy instruments (particularly credit ceilings), and auction-based indirect monetary policy instruments with access limits and other restrictions to limit the influence of insolvent institutions. A narrow banking structure would limit the activities of banks to the provision of payments services and require that they hold only safe assets (typically government securities). The provision of credit would be shifted to nonbank lenders, who would remain outside the official safety net that applied to banks. Direct monetary policy instruments, particularly bank-by-bank credit ceilings, have been viewed as an instrument, albeit an imperfect one, for both establishing monetary control and limiting the ability of insolvent institutions to expand at the expense of solvent institutions. The proposed restructuring of auctions of central bank credit so as to minimize the adverse selection and moral hazard problems has focused on institutional arrangements that attempt to control the credit risks assumed by the authorities by limiting access

to the credit auctions to solvent ("primary dealer") banks and by forcing other banks to borrow either from the primary dealers or from a central bank facility with very limited access.

These proposals represent short-term, second-best solutions for limiting the problems created by insolvent institutions. The ultimate solution will necessarily involve restructuring or closing of insolvent financial and nonfinancial institutions; the creation of an adequate system of prudential supervision; and the establishment of appropriate legal arrangements, accounting standards, and disclosure requirements.

Narrow Banking Proposals

A narrow banking structure represents the most direct attack on the problems created by insolvent institutions for both excessive risk taking in the financial system and monetary control. The use of a narrow banking structure has been only one element in a number of proposals regarding reform of the financial systems in transition economies (for example, see McKinnon (1991a and 1991b) and Rostowski (1994)). In an environment where it is difficult to determine which institutions are solvent and where prudential supervisory resources are limited, these proposals have stressed the need to improve the payments system and avoid excessive risk taking in the banking system. To achieve these objectives, it has been argued that a number of steps need to be taken. First, all unrestructured SOEs would receive their financing through the central fiscal budget.[12] Such a measure would limit moral hazard and adverse selection problems both by reducing the scale of risky lending that the banking system would undertake and by allowing the authorities to create incentives for restructuring the SOEs.[13] In addition, the banking system would be restricted to the provision of payments services and would be required to hold only safe assets (preferably government securities or deposits at the central bank). Deposit interest rates would be set marginally below the yield on safe assets or, alternatively, depositors could be charged for the payments services they receive. All pri-

[12] Banks could still provide payments services to SOEs. It would also be possible that banks could administer from the central fiscal budget the funds that SOEs receive.

[13] Perotti (1993) has suggested the use of conditional subsidies to unrestructured SOEs, which tie the availability of these subsidies to the formulation of restructuring and privatization plans by the management of the SOEs.

vatized and restructured SOEs and new private firms would be limited to self-finance or the nonbank financial market as a source of funds.[14]

Only as an adequate prudential supervision system is developed and commercial banks are restructured and privatized would banks be allowed to undertake commercial lending. While some proposals envisage a full resumption of lending activities, other proposals would allow only fully collateralized short-term lending to liberalized SOEs and other private firms. There would also be close prudential supervision of banks, and banks would be allowed to offer competitive lending and deposit interest rates. Most proposals have been vague about the expected duration of the narrow banking structure, but the broadening of banking activities would be clearly tied to the pace of the restructuring of insolvent financial institutions and enterprises and the development of an adequate institutional framework (including the establishment of adequate accounting, legal, and prudential supervision arrangements) that would facilitate the emergence of competitive financial markets.

If a narrow banking structure is utilized, maintaining monetary control would be relatively straightforward. Since banks would effectively face 100 percent reserve requirements, there would be no auctions of central bank credit to banks. The stock of base money could be expanded through the issuance of credit to the government and by purchases (for example, through discount window operations) of government securities held by commercial banks and foreign exchange in order to meet the liquidity needs of the public.

The major disadvantages of the narrow banking structure are threefold. First, the extension of credit by nonbank institutions would take place in an institutional environment that is subject to limited prudential supervision and whose depositors are, by design, excluded from the official safety net. It has been argued that this would give the owners and depositors greater incentives to monitor the activities of the managers of

[14]The rationale for limiting restructured SOEs and private firms to self-finance was that this would be the simplest technique for imposing financial restraints on these entities. As nonbank private capital markets (for example, markets for short-term commercial bills) began to emerge, the financial constraint on the nonbank firms would be relaxed, but the private lenders would also face bankruptcy if they made bad loans; this would introduce an element of market discipline. McKinnon (1991a and 1991b) has emphasized, however, that self-finance can yield such market discipline only in a low inflation environment. In a situation of high inflation and negative real interest rates, the state banking system may have to continue to provide credit to SOEs to prevent industrial collapse. Because interest rates are not used to ration credit, credit would have to be allocated administratively.

these institutions. However, once these nonbank institutions become large, it may become difficult for the authorities to allow them to fail. Second, adopting a narrow banking structure could make it more difficult to make an eventual transition to a broader banking structure (for example, universal banking) since bank managers would have little experience with commercial lending. Finally, a narrow banking structure could inhibit the development of other financial markets. For example, efficient government securities markets typically require the provision of liquidity from banks to securities dealers and brokers so that these markets' participants can effectively manage their portfolios.

Direct and Indirect Monetary Instruments

As an alternative to a narrow banking structure, it has been suggested the banking system and monetary control mechanisms of transition economies be designed to be similar to those that have been used in industrial and developing countries, with appropriate modifications to deal with the problems caused by insolvent institutions. One possibility would be to use direct monetary policy instruments, including credit ceilings such as were employed by many industrial countries in the 1950s and 1960s and continue to be used by many developing countries. Another possibility would be to consider how to modify the indirect monetary policy instruments, such as credit auctions or open market operations, so that the potential adverse selection, moral hazard and collusion problems are minimized.

Direct Monetary Policy Instruments

In a number of recent analyses, direct monetary policy instruments (encompassing credit ceilings, interest rate ceilings, and reserve ratios) have been discussed as a means of both establishing monetary control and limiting excessive risktaking in the financial systems of transition economies (see Begg and Portes (1992), Bredenkamp (1993), Hilbers (1993), Perotti (1993), and Thorne (1993)). For example, the central bank could establish the overall rate of expansion of bank credit that would be consistent with its stabilization program, and it could then specify the percentage increase in each bank's lending that would be allowed to take place during a particular period. Each bank would then decide on which individual projects would be funded under the ceiling. In most proposals, lending and deposit interest rates would be set by the authorities at levels designed to ensure a modest, positive real deposit rate and with a spread between lending and deposit interest rates wide enough to allow a rela-

tively efficient bank to earn a profit. Those banks that did not attract enough deposits to allow them to expand their lending in line with the credit ceiling would be able to obtain refinance credits from the central bank at a cost equal to or above the deposit rate.

Such arrangements would allow for a relatively straightforward monetary control mechanism. The overall expansion of the monetary base would come through central bank extensions of credit to the government and through a limited access refinance facility. Over time, greater flexibility could be added to this system by allowing banks to attract nondeposit sources of funds. Such subordinate debt could be used to fund lending outside the credit ceiling, and it would carry market-determined interest rates. Since this subordinated debt would not be subject to official guarantees, the bank's creditors would have a strong incentive to monitor the bank's activities; this would introduce an element of market discipline.

In addition to providing a direct mechanism for establishing monetary control, this institutional structure would limit the ability of insolvent financial institutions to expand at the expense of solvent institutions, both by limiting their ability to expand their activities (due to the credit ceilings) and by not allowing them to offer above average deposit interest rates. Nonetheless, such arrangements would not eliminate the activities of insolvent financial institutions, and, if such institutions engaged in excessively risky lending, the authorities could still face a potentially large public sector funding obligation when the depositors ultimately needed to be protected. The only way to avoid this problem would be to establish more restrictive credit ceilings for insolvent than for solvent institutions, but this would require that the authorities be able to differentiate between the two types of institutions, something especially difficult in the early stages of the transition to a market economy.

Perhaps the biggest potential problem associated with the use of credit ceilings is that it necessarily involves the bureaucracy in the credit allocation process, which opens up the scope for favoritism and bribery. If such bureaucratic interference occurs, then there could be an inefficient distribution of credit directed toward politically favored borrowers and a crowding out of new borrowers.

Indirect Monetary Policy Instruments

Using indirect, auction-based monetary policy instruments in financial systems dominated by insolvent institutions is a difficult undertaking; one has to consider carefully how typical market economy auction mechanisms must be restructured. As noted earlier, one of the key features of the indirect auction-based monetary policy systems in Western economies

is that the authorities rely on market participants to judge the day-to-day creditworthiness and solvency of individual financial institutions.[15] In particular, the short-term creditworthiness of commercial banks is judged by their ability to access the interbank market for reserve money. In this market, each bank typically establishes ceilings on the credit that it will extend to any other bank, which reflects its judgment about that bank's creditworthiness. In turn, the central bank limits its need to make creditworthiness judgments by engaging only in collateralized transactions with individual banks in its open market, discount window, or advances activities.[16] Banks that are excluded from the interbank market or draw heavily at the discount window are immediately subject to enhanced prudential supervision.

It has been suggested that one means of mimicking this system in a transition economy would be to create a two-tier banking system. The first tier would consist of those banks that the authorities could identify as creditworthy banks ("primary dealers"), and these banks would be the focus of the authorities' prudential supervision activities. Only the primary dealer banks would be allowed to participate in the central bank credit auction, and there would be limits on their access both to individual auctions and to the cumulative amount of central bank credit that is issued through auctions. Moreover, if the government securities market were adequately developed, then the auction could be conducted on a collateralized basis. The identification of which banks were creditworthy would necessarily involve a judgment by the authorities. But, in the absence of competitive markets, such a judgment is unavoidable. Indeed, the decision to open the auction to all financial institutions would suggest that the authorities have made the implicit judgment that all institutions are equally creditworthy.

All other ("second tier") banks would normally be expected to obtain funding through deposits or by borrowing from the primary dealer banks. The primary dealer banks would then play a key role in evaluating the creditworthiness of the other banks. Banks that were denied access to the interbank market of the primary dealers would have limited access to a central bank facility where interest rates would be tied to the rate established at the most recent credit auction. In deciding how much each second-tier bank would be allowed to borrow at this facility, the central bank would again have to make a judgment about that bank's viability.

[15] These market-based creditworthiness evaluations are supplemented by the authorities' prudential supervision.

[16] Nonetheless, central banks can (and do) establish limits on the access of individual banks to their discount window.

Since the authorities' prudential supervision resources would be focused on the primary dealer banks, it has been argued that the authorities may need to adopt uniform access criteria coupled with indicators that a particular bank may be having difficulties and therefore require special attention. There are a variety of access structures that could be used, but most would set period (e.g., monthly) and cumulative limits on the use of the facility and monitor the activities of banks that either fully utilize their access limits or offer above average deposit interest rates. To give banks that cannot access the interbank market an incentive to restructure, it could also be announced that the real size of this facility would be diminished over time.

The advantages of this institutional structure are that it would introduce market-determined interest rates, limit the credit risks assumed by the central bank (especially if credit auctions took place on a collateralized basis), and introduce credit evaluation techniques to the primary dealer banks. However, there are a number of potential problems and tradeoffs that could arise under this structure. First, given limited prudential supervision resources, the authorities would face a tradeoff between designating a large number of primary dealer banks (so as to increase competition in the credit auction) and the ability to effectively supervise the primary dealer banks. Second, if the set of primary dealers is relatively small, then it may be difficult to prevent collusion between the major banks in their bids at the credit auction. Moreover, such collusion could also affect lending and deposit rates. This would be reflected in relatively low real returns on deposits and a wide spread between lending and deposit interest rates. In an environment with inadequate disclosure requirements, poorly developed accounting standards, and uncertain property rights, the evaluation of the portfolio positions of individual banks, which would be vital for the evaluation of the creditworthiness of an individual bank by both the primary dealer banks and the supervisory authorities, would be highly uncertain. This process would be further complicated if the major banks were either owned or controlled by their major borrowers. Even in Western financial systems, where prudential supervision and market discipline are much stronger, these factors have often contributed to excessive risktaking by bank managers.

IV. Conclusion

While the use of indirect monetary policy instruments to establish monetary control in transition economies is a highly desirable medium-

term objective, a strong case can be made for linking the introduction of these instruments to institutional reforms that facilitate market discipline and strengthen prudential supervision. Premature reliance on auction-based indirect monetary policy instruments can give rise to adverse selection, moral hazard, and collusion problems that can create large public sector funding obligations because of credit risks assumed by the public sector.

During the period when market discipline and prudential supervision are weak, a narrow banking structure, direct monetary policy instruments, or specially structured auction-based indirect monetary policy instruments will be needed to deal with the problems created by insolvent institutions. None of these approaches is a panacea: all three have drawbacks. The narrow banking option would lead to credit being created outside of the banking system and could impede the development of the financial system. Direct instruments will necessarily involve the bureaucracy in the credit allocation process and are unlikely to rapidly eliminate insolvent banks from the system. An auction-based system specially designed to mimic the important features of markets in developed economies might result in collusion and insufficient competition.

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Use of Central Bank Credit Auctions in Economies in Transition

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A number of economies in transition have instituted central bank credit auctions as part of a package of reforms seeking to improve monetary control and foster money market development. This paper examines the use of those auctions and features of their design, including collateralization and access rules intended to minimize adverse selection and moral hazard. The implementation of credit auctions in Eastern Europe and the countries of the former Soviet Union is surveyed. The experiences of countries in Eastern Europe suggest that credit auctions can be a useful tool in the transition toward indirect monetary control and the development of interbank markets. [JEL E52, E58]

AUCTIONS OR tenders are used as means of allocating portions of central bank credit in many industrial and developing countries.[1] In these countries, credit auctions are used in combination with other

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[1] Money market operations in Germany, France, and Belgium can be described as credit auctions (Laurens (1994)). The central banks of Israel and Indonesia conduct daily auctions of reserves, while the central bank of Malaysia auctions government deposits and the Bank of Norway auctions central bank deposits and short-term deposits at the central bank (Klein (1994), Carling (1994), Norges Bank (1993)). Credit auctions have also been used to on-lend multilateral development funds in countries such as Chile and Bolivia (Guasch and Glaessner (1992)).

monetary policy instruments, including other central bank credit facilities, to manage bank liquidity or short-term interest rates. In a number of economies in transition from centrally planned to market-based systems, the central banks have begun to use credit auctions as part of broader packages of reforms to foster market-based monetary operations, promote money markets, and improve monetary control. However, while the monetary operations of central banks in market economies are supported by well-functioning interbank markets, adequate risk management, including the use of collateral, and effective banking supervision, these factors may be insufficiently developed in economies in transition.

This paper discusses ways in which credit auctions can be designed to reduce the negative impact of these deficiencies, and presents the experiences of some countries in transition that have implemented credit auctions as one of their monetary policy instruments. It takes as its starting point the present-day realities of many economies in transition: economic and financial activity cannot be put on hold until enterprise restructuring is completed, commercial banks form the core of the financial system, and these banks are heavily dependent on central bank credit.[2] This dependence stems from the concentration of household deposits in the savings banks and of credits with the specialized commercial banks inherited from the monobank era; low rates of deposit mobilization; and underdevelopment of interbank markets. These structural factors resulted in a need for central bank intermediation between banks and for extensive central bank financing of bank lending during the initial stages of transition (Sundararajan (1991)). In many economies in transition, the authorities have reduced the structural dependence on central bank credit over time.[3] Nevertheless, policymakers are still faced with the challenge of designing central bank credit facilities that can ensure monetary control and at the same time foster a smooth transition toward market-based indirect instruments.

[2] At the end of 1993, central bank credit to commercial banks was equivalent to 30–65 percent of the volume of commercial bank credit to the economy in some countries of the former Soviet Union.

[3] This was done in some countries by converting part of the outstanding central bank credit to long-term loans to be repaid in installments (e.g., Czechoslovakia, Macedonia, Poland), with the remainder used as short-term loans (including credit auctions) for monetary control purposes. In other countries, credit was gradually phased out as outstanding credits were repaid.

I. Credit Auctions as an Alternative to Administrative Allocation

In most planned economies, credit was allocated administratively to specific sectors or borrowers at preannounced interest rates. The main disadvantages of this approach are that the use of directed credit is prone to misuse and abuse, the pricing of credit may be inefficient, and administrative allocation procedures tend to favor the state-owned sector and do not lay a foundation for more market-oriented financial systems. An auction-based allocation system can allocate credit transparently, based on objective criteria. In the absence of distortions, auction-based allocation mechanisms function efficiently; that is, they assure that resources accrue to those that value them most highly and where they will be most productive (Feldman and Mehra (1993)). Furthermore, an auction-based system introduces market interactions and price flexibility, which can form a basis for further financial sector development.

When no restrictions are placed on the use of auctioned credit and on the interest rate in the auction, and banks act rationally to maximize profits, it would be expected that central bank credit will flow to banks that can make the best use of the available resources. Since the end use of funds will be determined by the commercial banks, the government will no longer be presumed to guarantee banks' loans, and banks will be forced to develop their credit analysis capabilities. State-owned enterprises will be forced to compete with other bank customers in terms of both price (loan interest and expected project rate of return) and quality (reliability of returns).[4]

Furthermore, credit auctions can be an important component of the package of measures needed to liberalize and manage interest rates and improve monetary control in economies in transition.[5] Regularly scheduled auctions introduce a market-based reference lending rate that can influence and guide the market as well as other central bank operations. Moreover, the central bank can control the volume of credit auctioned, taking into account other factors affecting bank reserves, and thereby influence either the level of bank reserves or the interest rate in the auction and in the interbank market.[6]

[4]The increased responsibility of banks will also put them in a position that will both require and permit an increased level of monitoring, which could be expected to result in improved corporate governance.

[5]Bredenkamp (1993) presents arguments in favor of the liberalization of interest rates in countries of the former Soviet Union early in the transition.

[6]At the same time, however, auctions must be viewed as part of a broader package of monetary control instruments. Although variations in the volume of

By introducing a flexible-price market in bank liquidity, auctions contribute to the development of the interbank money market, and thereby pave the way for strengthening indirect instruments and phasing out any direct controls on credit and interest rates. Early introduction of credit auctions allows the central bank to gain experience in market-based monetary control and, as money markets develop, sets the stage for more sophisticated open market operations. As banks learn to assess liquidity conditions and price credit through participation in the auction, they will become more active in managing their reserve positions, thereby stimulating money market dealing. Furthermore, imposing uniform and transparent access to credit will force banks that have historically been supplied by directed central bank credit to look at other sources, including the interbank market.

However, some of the assumptions underlying the expected efficiency of an auction-based system may not apply in economies in transition. Possible impediments to the use of uncollateralized credit auctions in these economies involve deficiencies in incentives and information, which can increase the credit risk to the central bank and compromise the allocational efficiency of the auction mechanism. Credit risk may result from adverse selection—the tendency to attract banks willing to offer the highest bids but bearing the highest risks; and from moral hazard—the inability of the central bank to influence or monitor how the borrowing bank uses the funds. Collusion among auction participants or market dominance by a few large banks might also affect the efficiency of credit allocation.[7] These problems could be more significant in economies in transition, where some banks may be insolvent, the banking system as a whole may not be competitive, banks' accounting and reporting are insufficiently developed, and banks' weak portfolios induce an inelastic demand for central bank credit, than in countries that use collateralized credit auctions in the context of well-developed banking systems and financial markets.[8]

Thus there are potential advantages and disadvantages to using an auction mechanism for the allocation of credit in economies in transition. The next section will discuss how auctions can be designed to minimize the problems of adverse selection, moral hazard, and collusion.

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credit auctioned can be used to withdraw liquidity from the system, effective monetary management may require other instruments to reduce excess liquidity when necessary.

[7] Although this by itself would not be expected to increase the credit risk to the central bank, the efficiency of resource use and the value of the auction rate as a reference rate would be diminished.

[8] For further discussion of these issues, see Mathieson and Haas (1995).

II. Design of Auctions to Control Credit Risk

Adverse selection and moral hazard may be addressed by requiring adequate collateral, formulating appropriate access rules for the auction, and setting limits on the volume of central bank credit that each bank is allowed to borrow.[9] Ideally, central bank lending should be collateralized by government securities or other high-quality paper, but in economies in transition, banks' securities holdings are often negligible, particularly in the early stages of reform. In these circumstances, the collateral requirement can be introduced only gradually. Since a program to develop treasury bills and other securities is typically part of the transition strategy, some requirement of collateral is feasible and desirable even if it covers less than 100 percent of the loan. In addition, the range of admissible collateral can be broadened to include such assets as foreign exchange and bankers' acceptances.[10] As the volume of treasury bills and government securities in the market increases, the rate of collateralization can be increased, gradually transforming the uncollateralized credit auctions into a repurchase auction.[11]

Rules of access are particularly important in the absence of adequate collateral. They must be uniform and transparent, and should include compliance with all mandatory prudential ratios, including foreign exchange exposure limits; compliance with reserve requirements; satisfactory repayment record for previous credits; compliance with reporting requirements; and satisfactory performance in clearing and settling payments. Even under uniform and transparent access rules, present uncertainties underlying the computation of prudential ratios may temporarily limit the effectiveness of these ratios in screening banks. In addition to access rules, credit limits as a ratio (or multiple) of each bank's deposits could be set. This would encourage banks to compete for deposit resources in the market. However, there is a trade-off between regulation and competition. The need to limit central bank credit risk must be balanced against the need to ensure fairly wide access by banks so as to permit adequate competition at the auction.

[9] While adverse selection in the auction can be addressed directly, the fungibility of money implies that the risk of moral hazard must also be addressed through improved bank supervision.

[10] However, the use of foreign exchange as collateral could encourage banks and enterprises to hold liquidity in foreign exchange and may provide further incentive for dollarization.

[11] This process will also create demand for collaterizable assets, reinforcing reforms in government finance such as the introduction of treasury bills and other government paper.

In many countries the auctioneer retains the right to screen bids and reject any that are deemed inappropriate. However, the option to reject a bid must be exercised judiciously so as not to diminish confidence in the fairness of the auction or interfere with the price discovery function of the auction. Frequently, central banks set a minimum auction rate to increase monetary control, discourage recourse to central bank lending, or coordinate the auction with other central bank facilities. Setting a floor interest rate could also prevent banks from colluding to bid a low interest rate. However, announcing the minimum rate in advance provides a focal point for collusive bidding. Even if the minimum rate is not announced, participants may guess the level and their bids may cluster around the assumed minimum rate. Although this outcome may appear to demonstrate collusive behavior, widespread bidding at the minimum rate may also indicate that there is excess liquidity at the floor price.

While the best insurance against collusion and uncompetitive behavior is a dynamic and competitive banking sector, some auction procedures may reduce the likelihood that collusive arrangements can be sustained. These include using sealed bids rather than an open outcry mechanism; awarding credit at a uniform price; limiting the postauction sharing of information with bidders; and limiting the share of total volume offered for which any one bank may bid (see Feldman and Mehra (1993) and Guasch and Glaessner (1993)).

Ultimately, the design of an auction cannot ensure against all risks, from both the credit risk and monetary control perspectives. Credit auctions are typically initiated on a small scale, allowing central banks to gain experience in monitoring borrower behavior in conditions of limited total risk. In any event, the likely alternative, administratively allocated credit, cannot control for these risks either. Economies in transition have long records of nonrepayment of directed credit. Administered allocation of credit led to outstanding loans being serviced through additional directed credit, a form of adverse selection in that the borrowers were those who could not repay previous loans. In the early stages of transition, assets in the portfolios of the newly created commercial banks were largely loans carried over from the previous systems of administrative allocation; of these assets, nonperforming loans were estimated at 15–20 percent in Czechoslovakia and Hungary, 20–30 percent of assets in Poland, and 40 percent in Bulgaria (Calvo and Kumar (1993)). Clearly, credit risk is significant under administrative allocation. Furthermore, the potential for collusion between enterprises, banks, and officials may be worse under a system that explicitly allows discretionary allocation than under a rules-based auction.

III. Experience with Credit Auctions in Economies in Transition

Credit auctions have been used both in Eastern Europe and in the countries of the former Soviet Union. The following discussion surveys the use of this monetary instrument in these countries, highlighting its role in paving the way for the development of interbank markets and more refined open market operations.

Eastern Europe

The central banks of Bulgaria, the Czech and Slovak Republics, Hungary, Macedonia, Poland, and Romania have used credit auctions both as a means to extend structural credit and as an instrument of monetary control (see Table 1). For example, the Bulgarian National Bank (BNB) auctioned one-month interbank deposits to inject and redistribute liquidity in the system. The liquidity need arose in part because of a lack of collateral that could be used to borrow from the Lombard facility; the redistribution need stemmed from underdevelopment of the interbank market and the commercial banks' lack of a deposit base (Mladenov (1992)). The auction allowed the BNB to replace some refinance credit with a competitive funding instrument, and enabled banks to become familiar with auction procedures and interbank trading of deposits (see Filipov (1992)). The National Bank of Macedonia (NBMa) also structured its refinancing auction to redistribute excess deposits among commercial banks.[12]

Most Eastern European countries have continued to allocate credit according to objective or administrative planning criteria in parallel with their credit auctions, sometimes to the detriment of the auction. The National Bank of Hungary (NBH) began in 1991 to offer some refinancing loans at regularly held auctions. Over the next few years, an increased proportion of short-term refinancing loans was awarded through auctions, replacing allocation based on banks' capital. However, long-term refinancing loans continued to be allocated for priority projects (Balassa (1992)). The National Bank of Romania (NBR) began to auction some of its credit to banks in January 1992. In the latter half of 1992, government directives resulted in a shift of NBR lending to direct allocation of subsidized credits (for on-lending to the agricultural sector) and the

[12]Through mid-1994, commercial banks had not offered funds through the NBMa. It is not clear whether banks perceive the NBMa as providing any implicit guarantee for interbank lending.

auction became inoperative. In July 1993, government deposits were shifted to the NBR to force banks to resort to the NBR for liquidity, and the auction of short-term NBR credit was reactivated in September 1993.

Auctioned credit has been used as a monetary control instrument both through direct liquidity effects and through interest rate transmission mechanisms. For example, the use of auction credit allows the NBR to retain short-term control over a significant portion of bank liquidity, and to effect a tightening or loosening of its policy stance on a week-by-week basis. In a number of countries, Lombard and other central bank rates have been pegged to the refinance auction rate. The State Bank of Czechoslovakia (SBCS) linked the rate on its daily refinance facility (1- to 7-day maturity, allocated on the basis of bank capital) to the auction rate in 1992. By the end of that year, the SBCS had phased out refinancing credit offered at the discount rate and made auctions of refinancing credit the primary indirect instrument of monetary control. The National Bank of Slovakia (NBS) reintroduced lending at the discount rate: credit auctions were dormant for a period, but by mid-1994 auctioned credit accounted for about 40 percent of NBS refinance. Since late 1993, the NBS has linked the discount and Lombard rates to the refinance auction rate. Interest rates on NBS auction credit have generally been below the Lombard rate and above the treasury bill rate, while interbank rates have hovered around the auction rate. The NBH used to set its minimum rate for the uncollateralized auction above the interbank rate to encourage banks to participate in the interbank market; from 1993 the repurchase rate has been a key determinant of interbank rates (National Bank of Hungary, 11–12/1993).

Interest rates on loans and deposits have tended to track the auction rate in most countries. The behavior of interest rates has not suggested that the auctions have attracted banks willing to pay any price with the expectation (or intent) of defaulting. Interest rates in the credit auctions have been responsive to changes in volumes auctioned and general liquidity conditions. For example, Romanian commercial banks have responded in the expected direction to central bank signals conveyed via the minimum acceptable bid rate (set by the NBR) or the auction volume. In December 1993 the volume was cut for one week, resulting in a jump in the average interest rate. The NBR raised its floor rate prior to the next auction, and banks raised their lending and deposit rates.[13]

[13] However, the minimum bid rate set by the NBR has provided a focal point for bidding, and possibly for collusion. In the first quarter of 1994, all bids tended to be at the minimum rate. As explained above, this may also indicate excess liquidity at the floor price.

Table 1. *Credit Auctions in Selected Eastern European Countries*

Country (auction since)	Purpose, frequency, volumes, and maturity	Rules of access and collateral	Limits on access	Auction procedures
Bulgaria: Bulgarian National Bank (BNB) (1991)	Replaced portion of refinance credit with competitive instrument. Banks bid on pool of 30-day deposits contributed by BNB and by commercial banks with surplus funds. Contributions to pool from commercial banks were rare in 1991–92; most banks lent surplus funds through the interbank market. Since 1993 biweekly deposit auction has consisted entirely of BNB funds. At end-1993, auctioned deposits were about 17 percent of BNB credit to banks, corresponding to about 5 percent of narrow money. In May 1994, BNB began to auction repurchase agreements.	Banks must have repaid outstanding debt from the previous auction. No collateral is required for auctioned credit. Repurchase agreements are fully collateralized by treasury bills.	BNB maintains targets in terms of percentage of capital that banks may borrow. However, such targets are applied flexibly depending on liquidity situation of banks and the BNB's current monetary policy.	Volume is announced one week before the credit auction. BNB sets a floor interest rate. Deposits are allocated at the average rate bid; this average interest rate is the only information released after the auction. Specific information on bids received is kept confidential. Repurchases are auctioned using a multiple price method. Banks offer repurchases and BNB selects those offering the highest prices until BNB's volume target is met.
Czech Republic: Czech National Bank (CNB) (1993)	Credit auction used for liquidity management and monetary control. Weekly auction of 1–4 week maturities is held. Auctioned credit represented about 20 percent of total CNB refinance credit (or 1 percent of base money) in 1993. CNB also conducts open market operations through 1–7 day repurchase agreements on treasury bills.	Collateral on auctioned refinance credit is equal to 40 percent of borrowing; the collateral is structured as a repurchase agreement. 1–7 day repurchase agreements are fully collateralized.		Banks may enter up to three bids in the credit auction. Credit is awarded to highest bids, up to the aggregate volume desired by CNB. Repurchase maturities and rates are set by CNB, and banks tender for an amount. Awards are prorated if total requested exceeds CNB target repurchase volume.

Hungary: National Bank of Hungary (NBH) (1991)	Uncollateralized credit auction provided short-term refinancing to replace credit allocated based on banks' capital. Biweekly auction of 2-week credit was used as instrument for short-term liquidity injections in parallel with central bank brokering of interbank deposits. Auctioned credit represented about 3 percent of central bank credit (0.5 percent of narrow money) at end-1991. Auction was discontinued in mid-1992 after failing to attract bids for several auctions. It was replaced by repurchase agreements in early 1993.	All banks and certain nonbank financial intermediaries were eligible to participate in the auction. No collateral was required for auctioned credit. Repurchase agreements are fully collateralized by government securities.	NBH reserved the right to exclude any institution from participation. In practice, the high minimum interest rate limited participation to the liquidity-starved larger banks.	Uncollateralized auction was for a preannounced volume. A minimum interest rate was set by NBH so as to be above the interbank rate. Credit was awarded at the price bid (multiple-price).
Macedonia: National Bank of Macedonia (NBMa) (1993)	Auction is intended to replace the refinancing of selective (directed) credits at predetermined rates. Auction of deposits is held biweekly as needed: banks may offer deposits for resale through auction, but in practice funds have only come from NBMa. Maturities offered are 14, 28, 56, and 84 days. NBMa has also purchased deposits. Selective credit continues to dominate NBMa lending; auctioned credit was on average only about 14 percent of NBMa credit in fourth quarter of 1993.	Banks must meet reserve requirements and must be current on all auction-related obligations. Banks offering deposits for resale may specify banks with whom they will not deal. No collateral is required.	NBMa Auction Committee sets limits on access based on each bank's level of required reserves. Banks offering deposits for resale may specify limits on amounts they will sell to specific banks.	Auction volume is preannounced. Banks submit scaled bids. Multiple bidding is permitted. Cutoff rate is set as the rate at which the volume offered and the volume bid come closest to matching. Credit is allocated at a uniform price to participants who bid above the cutoff rate.

Table 1. *(concluded)*

Country (auction since)	Purpose, frequency, volumes, and maturity	Rules of access and collateral	Limits on access	Auction procedures
Poland: National Bank of Poland (NBP) (1991)	Fully collateralized credit auction in form of repurchase agreements was introduced for monetary control; in particular, NBP sought to restrict banks' access to funds provided passively by NBP and replace these with facilities operated at the initiative of the NBP. Initially, weekly auctions of repurchases with 14-day maturities were conducted to inject liquidity. Since January 1993, reverse repurchases have also been executed; maturities of both instruments may range from 2 to 14 days. The amount of auction credit outstanding has ranged as high as 7.5 percent of total refinance credit, but is generally much smaller.	Repurchase transactions with NBP are open only to primary dealers. These banks have current accounts at NBP and are dealers in the money market. Repurchase agreements are fully collateralized by Treasury bills. Initially bank-discounted commercial bills and NBP bills were also used; these were discontinued in 1992.	NBP reserves the right to reject some or all offers.	NBP announces volume to be offered/purchased and the discount rate to be used to value the securities. Banks bid a repurchase price. Expressed as an interest rate, the difference between this price and the discount rate is the criterion for ranking bids. Banks may submit multiple bids; awards are at the prices bid.
Romania: National Bank of Romania (NBR) (1992)	NBR conducts a weekly auction of 1-week credits, which partially replace directed credits. In second half of 1992 a resurgence of directed credit resulted in auction becoming inoperative. Short-term credit auctions were resumed in September 1993 at an initial volume corresponding to 14 percent of outstanding NBR credit to banks. By end-March 1994, auctioned credit represented 36 percent of stock of NBR lending to commercial banks (equivalent to 10 percent of domestic credit to nongovernment).	Auction is open to all banks. No collateral is required for auctioned credit.	No formal limit is applied to a bank's borrowing from NBR. Initially, a limit was placed on the share of each auction for which any one bank could bid. The limit was non-binding and has been removed.	Auction volume is preannounced. Banks bid an interest rate for an amount of credit. Minimum allowable interest rate is set weekly by NBR. The auction would use multiple-price allocation, but tendency has been for banks to all bid at the cutoff rate except when there has been a significant change in the volume offered.

Slovak Republic: National Bank of Slovakia (NBS) (1993)	Auction of 30-day credits is held weekly, except when NBS determines that no additional liquidity is required. At end-1993, refinance credit represented about half of NBS credit to banks, or about 8 percent of base money. Since late 1993, Lombard and discount rates have been set with reference to auction rate.	Initially no collateral was required. Since April 1994, 10 percent collateral in the form of Treasury bills has been required.	Bids cannot exceed 50 percent of the amount offered at that auction. There is no limit on NBS credit a bank may have outstanding.	Volume is announced in the morning. By mid-day, banks submit up to three bids by fax. Bids are ranked by interest rate; credit is awarded to highest bidders at cutoff rate.
Czechoslovakia: State Bank of Czechoslovakia (SBCS) (1991–92)	Initially, auction of 30- and 90-day refinance credit was held monthly. Short-term refinance rates were linked to auction rate. During 1992, auction frequency increased to weekly, and 90-day credit was discontinued. By end-1992 refinance credit at a predetermined discount rate had been discontinued and auction of refinancing credit became primary indirect instrument of monetary control.	No collateral was required.	To ensure access by small banks, a bid limit was set at 50 percent of the volume offered in any given auction.	Volume was preannounced. Interest rate determination was based on a uniform-price auction procedure at some times and a multiple-price auction procedure at others.

Note: The information in this table was compiled in May/June, 1994.
Sources: Central bank bulletins; and IMF staff.

In general, banks are required to be in compliance with prudential and reserve regulations (to the extent that the central bank is capable of monitoring) to participate in auctions.[14] In addition, some countries have introduced restrictions to widen participation and encourage competition in the auction or to prevent excessive credit risk exposure to particular banks (Macedonia, Romania, and Slovak Republic).

There has been a trend toward increasing collateralization of bank borrowing from the central banks. The CNB has raised the level of collateral required for auctioned credit to 40 percent; at the same time, banks holding bills of exchange have access to a rediscount facility at a rate generally below the rate of auctioned credit. As collateralization of credit auctions moves toward 100 percent, the auction will become a repurchase facility. The BNB has not required collateral for the credit auction, but the increased availability of suitable collateral has reduced the need for credit auctions and increased usage of Lombard and discount operations at the BNB. Moreover, the BNB began using repurchase agreements in 1993, and during 1994 relied increasingly on this instrument, winding down the uncollateralized credit auction. Poland is an unusual case in that the National Bank of Poland moved directly to repurchase agreements soon after the introduction of treasury bills; thus the auction facility was fully collateralized from the start.

Uncollateralized credit auctions have diminished in importance as interbank markets have developed and commercial bank dependence on central bank credit declined. The Bulgarian auction's initial structural importance in intermediating between the State Savings Bank and other banks with less developed deposit-taking networks diminished as the interbank market developed. This, together with the introduction of treasury-bill-based open market operations for monetary control, allowed the outstanding volume of auctioned credit to be reduced from the equivalent of 17 percent of broad money at end-1991 to 1 percent at end-1993. At the same time, outstanding central bank credit to banks relative to domestic credit to the private sector declined from 21 percent to 9 percent. As the interbank market and other monetary operations developed in Hungary, commercial bank dependence on NBH credit declined from over 40 percent at end-1991 to 30 percent in 1992, and the auction became unattractive, in part due to the high minimum bid rate. The Czech refinance auction now mainly serves smaller banks that lack

[14] The process of putting in place a supervisory regime need not be extremely lengthy, and has in some cases been accomplished within the first few years of transition. Fully ensuring compliance may require further development of supervisory skills as well as restructuring of some banks.

sufficient rediscountable collateral and that do not have access to the interbank market. Czech interbank rates have at times been well below the auction rate, possibly indicating adverse selection in the auction.

The developments in the countries surveyed suggest that as the financial sector develops, in the absence of adjustments in auction design the riskiness of the credit auction may increase, since the worthiest counterparties will seek financing in the interbank market. The central bank may in fact be assuming the intermediation credit risk that the market refuses to bear; while this may be justified in the early stages of market development, it is not a sustainable position. A decline in participation in the auction coupled with significantly higher interest rates in the auction than in the interbank market may signal a need to review the purpose and structure of the auction.[15]

The trends in Eastern Europe also suggest that certain aspects of credit auctions can diminish in importance as the banking system develops. While in some countries the auction may continue to fulfill a structural function in that it redirects some amount of credit toward banks that do not have the collateral necessary to participate in the other facilities and are not considered appropriate counterparties for interbank lending, in countries where conditions have improved the focus of the auction has moved to short-term monetary control. The trend toward increased collateralization of borrowing from the central bank and increased recourse to interbank markets indicates that the use of an auction allocation mechanism is indeed in conformance with, and probably has helped foster, the development of these features of market-based financial systems.

At the same time, it should be noted that credit auctions have often been used side by side with direct instruments of monetary control; for example, even though Poland instituted a repurchase facility in 1991, bank-specific credit ceilings were only removed in 1993.[16] A credit auction should be implemented as part of a carefully designed financial program. The case of Romania, where government-dictated credit allocations superseded auctions and led to monetary control problems, highlights the fact that commitment to the overall financial program matters more than the design of any one instrument. The early implementation of market-based institutions can support, but is not a substitute for,

[15] It may also indicate that the auction is functioning as a lender-of-last-resort facility, suggesting the need to evaluate the condition of the banks still participating in the auction.

[16] For a discussion on the joint use of both direct and indirect instruments in transition economies, see Hilbers (1993).

consistent and well-formulated macroeconomic policies; even well-designed monetary instruments will not prevent the loss of monetary control if political commitment to appropriate policies is absent.[17]

Countries of the Former Soviet Union and Baltic Countries

Countries of the former Soviet Union have, in general, more fragile banking systems than those in Eastern Europe. Thus, the ex ante concern for moral hazard and loss of monetary control is greater. Nevertheless, in recent years, many countries of the former Soviet Union, including Kazakhstan, the Kyrgyz Republic, Moldova, and Russia, have relied partially on central bank credit auctions to allocate credit and to determine interest rates (see Table 2). Particular attention has been paid to elements of auction design, including collateralization, limits on participation, and the use of sealed bids.

The introduction of credit auctions for monetary management is intended to be associated with a phased reduction in directed credits and in the structural dependence on central bank credit. Although the amounts auctioned have been relatively small (generally below 20 percent of the flow of credits), there has been a gradual increase in the use of the auction mechanism in some countries. For example, in Kazakhstan, about 39 percent of the flow of credits in March 1994 was auctioned; in Moldova, this ratio reached over 80 percent in May 1994.

The auction mechanism has provided some flexibility in the implementation of monetary policy in the Baltic countries and the countries of the former Soviet Union. In Lithuania, the auction facility was activated at a critical time to provide liquidity at a penalty rate to banks with reserve deficiencies.[18] Given the volume of directed credit dictated by the Government in the Kyrgyz Republic, the net domestic assets target of the central bank was achieved by reducing the amount of auctioned credit. However, in some countries, such as Armenia, there has been limited room to implement an auction facility owing to the excess liquidity in the banking system. Maturities of auctioned credits in the countries of the former Soviet Union tend to be about three months, which is relatively

[17] The establishment of an auction can provide a benchmark for comparison of actual behavior (e.g., use of the auction relative to use of directed credit) with professed commitment to market mechanisms. Even if the auction is not operated ideally, it can give reformist groups (as well as bilateral and multilateral donors) an opportunity to point out backsliding.

[18] While interbank rates ranged from 7–9 percent a month, the rate at the auction was about 13 percent.

long for monetary control purposes but is shorter than directed credit had been. This reduction in maturity of central bank credit should increase monetary control and interest rate flexibility.

In a few cases, auction rules have been circumvented to provide additional auctioned central bank credit to a specific sector or bank. For instance, the National Bank of Georgia has often waived its own access rules with regard to large state-owned banks. The Bank of Lithuania has deviated at times from its own limits on access in order to provide additional credit to the agricultural sector. These procedures reduce transparency at the auction by mixing monetary and directed credit objectives; it would be preferable to use an administered window to provide such specific credits.

In some countries, such as Russia, Lithuania, and the Kyrgyz Republic, a minimum interest rate is established for the auction. For instance, the Bank of Lithuania rejected all bids at its first auction, indicating that the interest rates offered were too low. Bids at higher rates were offered and accepted at subsequent auctions. While in principle this may prevent low interest rates because of collusion, it may also reduce interest rate flexibility.

As noted earlier, collateralized lending and carefully defined access criteria reduce the potential for adverse selection in the auction process. In the absence of sufficient stocks of acceptable collateral in economies in transition, central banks in a number of countries have introduced partial collateralization to reduce the credit risk they face. For example, in the Kyrgyz Republic, the authorities require collateral equivalent to 10 percent of the loan.[19] In addition, in most countries the range of admissible collateral has been broadened beyond treasury bills to include foreign exchange holdings, promissory notes, and some less liquid assets.

In the absence of adequate collateral, it has also been desirable to limit commercial banks' access to the credit auction. Countries have restricted access by requiring banks to meet prudential norms. For instance, in Kazakhstan, of 200 banks only 50 meet prudential norms and thus are allowed to participate in the auction. However, appropriate access rules coupled with excess liquidity in the emerging interbank market may actually discourage participation in the auction; this has been observed in the Moscow region of the Russian Federation.

[19] Although credit auctions are fully collateralized in Russia, the effective rate of collateralization may be lower. Legal constraints limit the effectiveness of collateralization, since in principle Russia's current legislation on collateral permits the pledger to retain control (and possibly dispose) of the assets until the loan is actually in default.

Table 2. *Credit Auctions in Selected Baltic Countries and Countries of the Former Soviet Union*

Country	Purpose, frequency, volumes, and maturity	Rules of access and collateral	Limits on access	Auction procedures
Armenia: First auction held in July 1993	Maturity of credits is 9 months. Auctions have been held irregularly. In early 1994, few banks participated in the auction and little credit was extended using this mechanism. Sound banks were not interested in part due a lack of secure lending opportunities.	Participants must meet prudential norms.	Banks may only bid for up to 10 percent of the volume auctioned.	Minimum interest rate is the refinance rate. Multiple-price auction method is used.
Belarus: National Bank of Belarus (NBB) First auction held in February 1993; auctions were discontinued late in the year.	Authorities planned to gradually replace directed credit with auctioned credit and to use auction rate as the basis for setting the refinance rate. By March 1993, 11 percent of flow of credits was auctioned. A quarterly ceiling on total amount auctioned was set by NBB Board. Auctions were held irregularly. Maturity of credits varied between 2 weeks and 3 months.	Interbank lending collateralized with promissory note.	Banks may only bid up to 100 percent of their paid-in capital. Overall liabilities of commercial banks may not exceed 20 times capital.	Credit auctions conducted at stock exchange. Auction proceeds by gradually increasing interest rate until only one bidder remains.
Georgia: National Bank of Georgia (NBG) First auction held in January 1994	Auctions held irregularly. Amounts auctioned are determined by the volume of maturing directed credit. Banks may onlend to any sector but not to other banks. In practice, moral suasion may be used to direct lending to specific sectors. (There is concern that some banks may be using auction proceeds to speculate in exchange market.) Maturity of credits is 90 days with interest payable on a monthly basis	Participants must meet prudential norms, but often this access rule is waived for the large state-owned banks. Deposit at NBG required prior to auction.		Bids submitted before auction, but banks may modify their bidding price at auction. Auctioneer states a minimum interest rate for each lot and auction proceeds by gradually adjusting the rate to equate supply and demand.

Kazakhstan: National Bank of Kazakhstan (NBK) First auction held in September 1992	Authorities plan to gradually replace directed credit with auctioned credit. In March 1994, about 39 percent of the flow of credits was auctioned. The maturity of credits has been 3, 6, and 9 months, but NBK plans to limit it to 6 months. Auctions are held twice a month.	Participants must meet prudential norms; Banking Supervision Department provides a list of qualifying banks. NBK uses fixed assets as collateral.	No limits on credit have been established.	Bids must be submitted in sealed envelopes. Number of bids submitted by any one bank is limited to five. NBK moved from a uniform-price auction method to a hybrid method and subsequently to a pure multiple-price auction method. No minimum interest rate is predetermined.
Kyrgyz Republic: First auction held in May 1993	Authorities plan to gradually replace directed credit with auctioned credit. Auctions are held irregularly. Maturity of credit varies between 3 and 4 months.	Banks must comply with prudential norms, meet reserve requirements, and present their balance sheet regularly. Initially, banks with overdrawn correspondent accounts were excluded from auction. Collateral requirement was initially 25 percent of credit granted, but later was lowered to 10 percent.	Cumulative amount for which a bank is allowed to bid may not exceed 50 percent of the auctioned amount. The overall amount of credit granted to each bank may not exceed 20 times its capital.	Banks submit sealed bids. Number of bids submitted by any one bank is limited to five. Credit is extended following a uniform-price method, with lowest bid as the clearing rate. Minimum refinance rate equal to clearing rate at the previous auction was introduced by the National Bank in August 1993.
Latvia: First auction held in November 1993	Bank of Latvia auctions about 90 percent of new credit extended. Auctions are held on a weekly basis. Maturity of credits is 2 months.	Participants required to meet prudential norms. No collateral is required.	The overall amount of credit granted to a commercial bank may not exceed 50 percent of the bank's capital and reserves plus 5 percent of its deposit liabilities.	Bids are submitted in sealed envelopes. A multiple-price auction method is used. The minimum rate is not preannounced.

Table 2. *(concluded)*

Country	Purpose, frequency, volumes, and maturity	Rules of access and collateral	Limits on access	Auction procedures
Lithuania: First auction held in April 1993; auctions were terminated with the introduction of a currency board in April 1994	Bank of Lithuania conducted auctions for structural and monetary purposes. In April and May 1993 auction facility was used to provide credit to banks with reserve deficiencies. It was also used to extend credit to agricultural sector. By March 1994, about 10 percent of flow of credits was auctioned. Maturity of credits varied from 1 to 2 weeks.	Banks were not required to meet prudential norms.	Each bank was only allowed to bid up to 5 percent of its deposits (net of time deposits at the central bank). At times, the Bank of Lithuania relaxed this limit to extend additional credit to the agricultural sector.	Bids were submitted by fax. Multiple-price auction method was used. No minimum rate was preannounced.
Moldova: First auction held in August 1993	In May 1994, over 80 percent of the flow of central bank credit was auctioned. Auctions held once a month. Maturity of credit varies from 3 to 6 months.	Banks must meet prudential norms to access auction. Collateral demanded in some cases.	Each bank is only allowed to bid for up to 50 percent of the auctioned amount.	Sealed bids used. Commercial banks state amounts desired and interest rates offered. Banks pay their bidding price. No minimum rate is predetermined.

Russian Federation: Central Bank of Russia (CBR) First auction held in February 1994	Auctions held on a monthly basis. Maturity of credit is 3 months.	Participating banks must observe CBR regulations on bookkeeping and prudential requirements, should have no outstanding overdraft or arrears with the CBR, and must have been registered for a minimum of 1 year in CBR's bank registry. Banks must provide 100 percent collateral; acceptable collateral includes hard currency deposits and balances in correspondent accounts.	No bank may borrow more than 25 percent of the amount allocated to the relevant regional center. Banks are subject to an overall borrowing limit equivalent to twice capital or 10 percent of assets, whichever is lower.	Each regional center is assigned a volume to be offered at auction. Bids are submitted only by banks' head offices, to appropriate regional center. Participants submit written bids. Multiple-price auction method is used with a floor price equal to the CBR refinance rate.
Ukraine: National Bank of Ukraine (NBU) First auction held in May 1993	NBU held one auction in May 1993 and one in May 1994. In 1993 auction was discontinued to provide directed credit; in 1994 it was stopped because of lack of secure lending opportunities for commercial banks. Purpose of the auctions was to provide a portion of refinance credit at market rates. All credit offered had a maturity of 3 months.	No collateral required at auction.		Bids were submitted in sealed envelopes. Multiple-price auction method was used. The minimum interest rate was the refinance rate.

Note: The information in this table was compiled in May/June 1994.
Source: IMF staff.

In addition, to manage the credit risk exposure of the central bank, some central banks have placed limits on individual banks' access to central bank credit. For example, in the Kyrgyz Republic the total amount of credit granted to each bank may not exceed 20 times its capital. In Russia, commercial banks are subject to an overall borrowing limit equivalent to the lower of twice capital or 10 percent of assets.

Although the use of credit auctions in the countries of the former Soviet Union is relatively new, these safeguards appear to have achieved their purpose. For instance, low participation in the Moscow region of the Russian Federation suggests that the CBR auction did not attract high-risk borrowers that had been barred from accessing the local interbank market.

IV. Conclusions

This paper has examined the use of auctions as a means of allocating central bank credit. Central bank credit in economies in transition often serves both a structural and a monetary role, and is sizable in volume. The structural need for central bank credit can be reduced over time by commercial bank deposit mobilization, the development of interbank and money markets, and the development of securities markets to provide enterprise financing from outside the banking system, but it is unrealistic to expect a rapid reduction in the dependence on central bank credit. Both administered and market-based allocation coexist in most countries, even those that depend primarily on indirect instruments for monetary control. Thus, at least some portion of central bank credit in economies in transition can be extended using a market-based allocation mechanism that will facilitate the subsequent shift to market-oriented instruments of monetary control; this can usefully be done early in the transition process.

Credit auctions can be effective as a monetary instrument; central bank determination of volume and access procedures allows control of liquidity expansion and influence over interest rates. Operated flexibly, auctions have the potential to allocate credit in an economically efficient manner and provide the basis for further development of money markets and more refined indirect instruments such as repurchase facilities. The price discovery process inherent in an auction provides a market-based reference rate that can be used both inside and outside the central bank. Elements of auction design regarding access rules, collateralization, and auction procedures can ameliorate or prevent some of the problems associated with information and incentive deficiencies.

The evolution from uncollateralized credit to fully collateralized indi-

rect instruments and from extensive dependence on central bank credit to greater use of interbank markets requires an appropriate transition strategy. The experiences of countries in Eastern Europe suggest that credit auctions can be part of such a strategy, providing a suitable instrument to effect monetary control and at the same time promote the use of market-based indirect instruments. However, while the auction can serve as a catalyst for further market development, it also has its limits. The central bank should not allow the auction to become a permanent substitute for an interbank market, or to become the refuge of uncreditworthy banks after the other banks have moved on to interbank or deposit-based sources of funds.[20] Use of a rule-based allocation procedure does not relieve the authorities of the need to implement consistent and well-formulated macroeconomic policies.

The early use of auctions should be associated with a phased reduction in directed credits and in structural dependence on central bank credit, and with further development in other areas of the central bank's responsibilities, notably bank supervision and the payments system. As part of such packages of reforms, credit auctions in several Eastern European countries appear to have successfully paved the way for the development of interbank markets and more refined open market operations, and do not appear to have resulted in excessive credit risk or monetary expansion.[21] Some countries of the former Soviet Union have also seen positive results from their early efforts to conduct monetary operations using credit auctions. It is hoped that in these countries too the auction will provide an institutional basis for further market-oriented development.

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[20] One way to avoid this is to increase the rate of collateralization.

[21] This must, of course, be viewed as a preliminary conclusion. While it is difficult to demonstrate the absence of an event (and virtually impossible to prove that it will never occur), the restrictions on participation seem to have been reasonably effective in averting defaults. Furthermore, monetary control lapses have not been attributed to the credit auctions.

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