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analysis

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UNIVERSITY OF CALIFORNIA, *at Berkeley* DEPT. OF  
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Working Paper No. 375

THE IMPACT OF PRICE RIGIDITIES: A COMPUTABLE  
GENERAL EQUILIBRIUM ANALYSIS

by

Mathias Dewatripont and Sherman Robinson

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THE IMPACT OF PRICE RIGIDITIES: A COMPUTABLE  
GENERAL EQUILIBRIUM ANALYSIS

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## Abstract

This paper uses a computable general equilibrium model of Turkey to explore the empirical effect on adjustment to various macroeconomic shocks of a variety of "structuralist" rigidities. Four types of rigidities are considered: exchange rate rigidity leading to premium rationing and rent seeking, wage rigidities leading to unemployment or labor scarcity, investment-savings imbalance leading to rationing of private consumption--forced saving--or to overall Keynesian unemployment, and sectoral price rigidity leading to consumption or supply rationing. In a series of comparative statics experiments, we explore the impact of, and interactions among, these different types of rigidities. In general, the results indicate that interaction effects are very important, especially between the macro closure rule, which specifies how investment-savings balance is achieved, and the other rigidities. Price rigidities are most damaging when a shock necessitates large relative price changes in a Walrasian world. Also, price rigidities are much more harmful when they lead to situations of excess supply rather than excess demand.

## TABLE OF CONTENTS

	<u>Page</u>
I. Introduction . . . . .	1
II. Price Behavior in Macroeconomic Theory . . . . .	4
III. Structure and Assumptions of the CGE Mode . . . . .	8
IV. Types of Rigidities . . . . .	10
A. Exchange Rate Rigidity . . . . .	10
B. Wage Rigidity . . . . .	13
C. Sectoral Price Rigidity . . . . .	14
D. Overall Savings-Investment Balances . . . . .	15
V. Experiments: Description and Result . . . . .	18
A. Effects of a Decrease in Foreign Capital Inflow . . . . .	18
B. Effects of a Lower Government Deficit . . . . .	23
C. Effects of an Increase in Real Wages . . . . .	26
VI. Conclusion . . . . .	32
Footnotes . . . . .	34
References . . . . .	37
 <u>Tables</u>	
Table 1. Structure of the Turkish Economy in 1981 . . . . .	11
Table 2. Composition of Savings in Turkey, 1981 . . . . .	12
Table 3. Effects of a Decrease in Foreign Borrowing of \$2 Billion . . . . .	20
Table 4. Effects of a Decrease in Government Deficit . . . . .	27
Table 5. Effects of an Increase of 10 Percent in Real Wages . . . . .	29
Table 6. Consumption Rationing After an Increase of 20 Percent in Real Wages . . . . .	30

# THE IMPACT OF PRICE RIGIDITIES: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

## I. Introduction

Walrasian general equilibrium theory is at the core of neoclassical economics. It is backed by strong theoretical results and provides a coherent view of how a market economy works. While it is widely used in fields such as public finance, development economics, and international trade where there is an explicit focus on multisector analysis, its methods are also applied in macroeconomics, especially in the "equilibrium approach to business cycles" of Lucas, 1972, 1977; Barro, 1981; and Sargent and Wallace, 1975. On the empirical side, computable general equilibrium (CGE) models, starting from the Walrasian paradigm, have been used to analyze problems of economic development, income distribution, international trade, and tax analysis.<sup>1/</sup>

A general feature of theoretical and empirical Walrasian models is stability of aggregate production in the face of anticipated exogenous shocks and efficient and almost costless adaptability to these shocks. The main problems appearing in Walrasian models generally involve dead-weight welfare losses arising from misallocation of resources due to distortions from taxes or imperfect competition. Real-world reactions to exogenous shocks seem, however, to be much less quick and efficient. A number of potential reasons could account for this gap between model behavior and actual economies: coordination problems, instabilities, or an incomplete set of markets. In this article, we focus on another major factor: the functioning of the price system.

The Walrasian assumption of complete price and wage flexibility has been a source of debate in economics since Keynes, and the fixed-price, quantity-

constrained literature (Barro and Grossman, 1971; and Malinvaud, 1977; among others) has strengthened interest in the controversy. Our goal is not to pursue the theoretical debate on the rationale for price fixity and non-Walrasian unemployment. The theoretical consequences of exogenous price rigidities have been widely discussed in the fixed-price literature which has concentrated on spillover effects of quantity constraints. Substantial theoretical shortcomings still plague the fixed-price approach; but the same is true for the Walrasian approach. We will provide only a brief summary of current debates and then focus on the empirical relevance of price rigidities. We begin with a Walrasian multisector CGE model, introduce successive rigidities, and ask the questions: "Do they create important distortions, and, how much do they matter?" Our results indicate, in specific situations, the empirical importance of potential price rigidities.

Our empirical investigation is based on a multisector computable general equilibrium model and, hence, departs from the theoretical macromodels used in the fixed-price literature.<sup>2/</sup> The use of a CGE model allows us to consider a wider set of prices and to include the sectoral effects of an aggregate shock. This approach is important, first, because price rigidities arise in the real world through a variety of different channels, for example, government intervention, international agreements, imperfect competition, and labor-market institutions. A second reason is that price rigidities include spill-over effects by which quantity constraints on one market have effects on the rest of the economy. These spillovers can only be captured in a multisector model.

The use of a CGE model also implies that we begin with a structural, explicit picture of agents' behavior. Our starting point is a transparent and



widely accepted Walrasian representation of the economy from which the hypotheses concerning rigidities and their consequences will appear unequivocally. Our approach is more in the spirit of the fixed-price literature than of the econometric, reduced-form models used in the macroeconomic literature. While a multisector CGE model provides important advantages, it also has some limitations arising mainly from its strong Walrasian spirit. The CGE model focuses on relative prices and resource allocation in a real framework. It does not include financial assets and has nothing to say about inflation. We discuss below the structure, assumptions, and shortcomings of the CGE model.

The empirical experiments focus on the effects of aggregate shocks (internal and external) on a static CGE model. We use a five-sector model of the Turkish economy, but the model should be thought of as representative of a typical middle-income economy. For each type of aggregate shock, we introduce successively various types of rigidities on the exchange rate, sectoral prices, and wages and evaluate their impacts relative to a purely Walrasian model. We also link the problem of price rigidities to the "macroclosure" problem of CGE models--that is, the way in which overall savings and investment are equilibrated. Such a link is important since the assumption of price rigidities is at the core of "structuralist" macromodels.<sup>3/</sup>

The plan of the article is as follows: Section 2 gives a brief summary of the debate on price behavior in the macroeconomic literature. The structure and assumptions of CGE models are discussed in section 3. Section 4 details the various rigidities introduced into the model and our attempts to capture spillover effects. The results of the experiments are presented in section 5, and overall conclusions are summarized in section 6.

## II. Price Behavior in Macroeconomic Theory

One should be able to evaluate the advantages and shortcomings of theories of price behavior with respect to the following questions: (1) Why are prices rigid or flexible? (2) What are the consequences of their behavior? (3) How is short-run price behavior reconciled with long-run price theory, i.e., how do prices move when they do move? All agree that prices are sometimes fixed, mainly by the government (exchange-rate systems, agricultural price support policies, incomes policies, wage-price controls, etc.), but also by trade unions or business cartels. What has been debated for decades is the prevalence of price and wage rigidities in the private sector and their persistence in the face of competition.

Intense debate started in the 1930s with the Great Depression. At that time, Keynes and his neoclassical opponents such as Pigou and Hicks recognized the existence of wage rigidity. The difference was that Keynes insisted on nominal wage rigidity and the potential for government intervention, whereas neoclassical authors stressed real wage rigidity enforced by trade unions and the need for wage restraint by those institutions. For Keynes, the generic source of wage rigidity was not trade unions but workers' concern for relative wages which prevented easy wage cuts at the microeconomic level. The modern fixed-price literature has extended rigidities to output prices but without emphasis on the source of price rigidities.<sup>4/</sup> The main focus has been on the consequences of these rigidities, and the literature has been much less successful in dealing with the sources and limits of price rigidities. See Drazen (1980) for a good survey of work in the area. General reasons for price rigidities have been advanced by a number of authors.

Transactions costs in various types of markets where long-term relationships are desirable--for example, the labor market or "customer market" (Okun, 1982)--can optimally yield price stability, even at the cost of quantity rationing. Some authors have rationalized labor contracts on that basis (Fischer, 1977; Taylor, 1979; Gray, 1978; Blanchard, 1979). Hicks (1974) has proposed a two-sector version of the economy (fixed-price and flexprice sectors) on the same grounds. Asymmetric information has also been stressed as a factor leading to price rigidity in situations of bilateral monopoly with productive inefficiency as a consequence, for example, in the labor market where the marginal revenue product of labor is known only to the firm and the reservation wage only to the worker (see Hall and Lazear, 1982). Asymmetric information can also lead to disequilibrium in the presence of adverse selection. For example, lowering wages at the individual firm level may induce the most productive workers to leave (Weiss, 1980), and raising interest rates can lower the quality of debtors (Stiglitz and Weiss, 1981). The efficiency-wage literature has been devoted mainly to these problems for the labor market (see Yellen, 1984 for a survey). Price setting by agents, on the basis of perceived demand curves, may also lead to price rigidities, for example, if the perceived demand curve is kinked. For a complete discussion of the idea and its limitations (see Drazen, 1980).

The underlying argument is that, in many markets, price and wage rigidities are optimal (for some period) even if productive inefficiencies result as an unavoidable consequence. This general view of the world is rejected by "equilibrium" theorists who stress the vagueness of these rationales. They stress the strength of competitive forces in the absence of regulation and the fact

that rational agents should not leave mutual gains from trade unexhausted (Barro, 1981). Moreover, price stability has been justified on the basis of agents' risk aversion leading to implicit contracts that combine price or wage stability (for risk-sharing purposes) and Walrasian levels of transaction (at least in the case of symmetric information). In the view of equilibrium theorists such as Barro (1981), this argument implies that the main element of flexible price theories--productive efficiency--is compatible with price rigidities and that these theories are, therefore, the best with which to analyze resource allocation and macroeconomic policies. They are ready to concede that asymmetric information can create inefficiencies, but they do not see this as a major element of the debate in macroeconomics.

It is probably safe to say that the rationales for price rigidities (transactions costs, information limitations, or risk aversion) or price flexibility (competitive forces insuring productive efficiency at every moment in time) are all somewhat unsatisfactory and that the discussion is still open. Future theoretical research should certainly address this problem because various assumptions on price behavior have been shown to generate widely different theoretical results in macroeconomics.

There also has been much research devoted to our second main question, the consequences of price behavior. The main debates of the 1930s were summarized by Hicks in the IS-LM model in which wage rigidity is shown to generate involuntary unemployment. The fixed-price literature cited above has broadened the set of rigid variables and stressed the importance of spillover effects derived from agents' constrained optimization problems. The features of the fixed-price, quantity-constrained equilibria are well understood. The same is true for the equilibrium view of the world, where imperfect information has

been used to derive results compatible with some stylized facts of the business cycle (Lucas, 1972, 1977; Sargent and Wallace, 1975; Barro, 1981). Finally, the implicit contract view has been shown to generate Walrasian outcomes in the case of symmetric information (see Azariadis, 1979), but the results with asymmetric information (see, for example, Hart, 1983) are still very tentative and dependent on particular assumptions. Even if problems persist in this area, much more is known than for the previous problem; and the sharp contrast concerning the potential for government intervention between the fixed-price view and the equilibrium view is there to stay.

As far as the third question is concerned (the link to long-term price determination), no approach can claim to provide a perfect answer. The equilibrium approach has the advantage of presenting a consistent theory for the short and long run. However, it assumes that prices move to achieve Walrasian equilibrium without explaining how this is done. While this is perhaps a reasonable assumption in a long-run model in which there is less concern with the process of price determination, it is a weakness in a short-run adjustment model. The Walrasian auctioneer is, at best, a convenient fiction and; as stressed by Arrow (1959), there is no room in these models for price setting by economic agents.<sup>5/</sup>

If the equilibrium view presents shortcomings in explaining price changes, especially in the short run, it is certainly a more serious problem for the fixed-price theory. As Drazen (1980, p. 236) says:

"The main question, however, is not what happens when prices don't move, but why prices don't move. . . . What is necessary is a model of endogenous price behavior, showing that prices don't move to clear markets, not because they are exogenously constrained from doing so, but because no price-setting agent (or agency) finds it in his interest to change prices."

Several attempts to explain price changes coupled to rationing are surveyed by Drazen (1980). They are, for the most part, based on the assumption of price-setting agents who have imperfect information about their demand curve. The main problem, however, is to avoid making ad hoc assumptions based on conjectures about demand without at the same time allowing for too much information (which would yield the Walrasian outcome). As stressed by Drazen (1980), fixed-price theorists have not succeeded in doing this, so price dynamics remains their weakest point.

All in all, one can safely conclude that neither equilibrium nor fixed-price theories provide fully satisfactory explanations of real-world price behavior. The first theory is probably more elegant and rigorous from a purely theoretical standpoint and is, perhaps, more applicable in the long run; but the second matches more closely the stylized facts of actual economies undergoing adjustment to shocks. In the rest of the paper, we accept the theoretical framework of the fixed-price theory and analyze the empirical importance of various rigidities by themselves or combined with each other. For this purpose, we first discuss in the next section the CGE model that provides the framework of analysis.

### III. Structure and Assumptions of the CGE Model

For this study, we use a static general equilibrium model. Intertemporal optimization by agents and the role of expectations are, therefore, not taken into account. Moreover, the focus is exclusively on the real sector of the economy with financial assets excluded from the analysis.

Firms are assumed to maximize current profits, subject to a constant elasticity of substitution production function for capital and labor and an

input-output technology for intermediate goods. Aggregate investment is assumed to be exogenous, and its sectoral composition by origin and destination is determined by fixed-share coefficients. Sectoral capital is immobile, but labor is allocated between sectors in order to equalize its marginal revenue product across the economy.

As far as households are concerned, their labor supply is fixed exogenously. Income is spent following a Cobb-Douglas utility function in all consumption goods and real savings. This implies constant savings shares out of income as in the Keynesian tradition.

The external sector follows the Armington (1969) story on the import side. Domestic and imported goods are assumed to be imperfect substitutes, and domestic agents demand constant elasticity of substitution mixes of both, where the optimal mix (identical across uses but sector-specific) is determined by the ratio of import to domestic prices. Import prices include a fixed world price (small-country assumption) plus tariffs and, possibly, a rationing premium (depending on the model variant). Exports are given by sectorally fixed ratios to production. While alternative treatments of exports that allow price responsiveness are feasible to implement, we chose this specification to focus on import demand adjustments.<sup>6/</sup> Foreign borrowing and international reserve changes are assumed to be exogenous (reflecting constraints on borrowing availabilities). Balance-of-payments equilibrium is then achieved either through a flexible exchange rate or through import rationing.

Our experiments use a five-sector model of Turkey based on data for 1981. Turkey can be thought of as a typical middle-income country, and the results probably generalize even beyond this category of countries. Tables 1 and 2 give information on the structure of production and demand in the economy as

well as the composition of saving (given by fixed rates for all categories of agents).

#### IV. Types of Rigidities

We introduce rigidities on the foreign exchange, labor, and individual commodity markets as well as in the aggregate savings-investment balance. For each type of rigidity, we specify spillover effects and rationing rules. The fixed-price literature has focused mainly on the first problem and much less on the second. Rationing mechanisms raise a number of theoretical problems. If, for example, buyers of a consumption good are rationed, what determines how much each agent can buy? Can agents influence the total amount that they receive (i.e., is the rationing scheme manipulatable)? Have agents any incentive to cheat (e.g., demand more than they want in order to relax their constraint)? Drazen (1980) also stresses the difference between deterministic and stochastic rationing rules and points to the fact that fixed-price theories have not solved the problems of how rationing rules emerge and function.

The mechanisms we specify are quite simple, and we will not attempt to tell a convincing microeconomic story to justify them. After much numerical experimentation, however, we are convinced that our empirical results are insensitive to the choice of rationing rules. For our purpose, the shortcomings of fixed-price theories on this aspect are not too important.

##### A. Exchange Rate Rigidity

The existence of rigidity in the exchange rate is not a matter of controversy. Since we have added the assumption of limited foreign borrowing (which is realistic for middle-income countries), exchange rate rigidity leads to import rationing if the exchange rate is "too high." Note that this last



TABLE 1

## Structure of the Turkish Economy in 1981

	XD	INTER	CD	GD	ZD	ED $\frac{ED}{XD}$	Consumption shares	
							$\frac{EM}{XD-ED}$	percent
	billion lira (Turkey)							
Agriculture	2,511	924	1,252	3	1	5.5	0.7	28.0
Mining	157	122	11	1	0	13.5	18.9	0.3
Consumer goods	1,702	421	917	23	1	15.2	2.6	20.9
Other industries	2,385	1,411	424	47	366	4.8	46.6	13.8
Services	4,218	1,080	1,618	588	738	4.6	2.9	37.0
Sum or average	10,974	3,959	4,223	662	1,106	6.6	12.2	100.0

Notes: XD, output; INTER, intermediate sales; CD, domestic consumption (private);  
GD, domestic government consumption; ZD, domestic investment; ED, exports; EM, imports.

TABLE 2  
Composition of Savings in Turkey, 1981

	Lira (Turkey) billions	Composition percent
Household saving	336	20.8
Firms saving	358	22.2
Government saving	918	57.0
Sum	1,612	100.0

characterization means too high relative to the numeraire, since the model is homogeneous of degree zero in all prices, wages, and the exchange rate; the aggregate price level is taken as numeraire. Variation in the real exchange rate--the relative price of tradables and nontradables--provides the equilibrating mechanism.

Exchange rate rigidity can lead to rationing of the demand for foreign exchange and, thus, of imports. We assume that resale of rationed imported goods leads to an equilibrium "import premium" level that induces agents to desire a ratio of imports to domestic goods consistent with balance-of-payments equilibrium. These premia are assumed to accrue to importers which are largely sectors using imported intermediate and capital goods. The existence of these premia, however, means that rents are available and can generate rent-seeking behavior. We adopt this approach, first stressed by Krueger (1974), and assume that this behavior creates efficiency losses (in terms of total factor productivity declines) proportional to the extent of available rents.<sup>7/</sup>

#### B. Wage Rigidity

The model includes agricultural and nonagricultural labor with one clearing wage for each category. When the prevailing wage on one labor market is too high, unemployment results. The rationing rule is simple: firms are on their demand curves for labor and workers are off their supply curves. The unemployed workers disappear from the system in that, without income, they have no effective demand for goods. In a CGE model that does not include financial assets, we cannot compute the spillover effect on the consumption-savings choice. We, therefore, assume, as in traditional macromodels, that the savings

propensities out of income are unaffected by unemployment. Note that a rigorous modeling of this spillover effect would require the presence of financial assets and the specification of expectations of future earnings.

When the prevailing wage on a labor market is too low, firms are rationed; as a consequence, they decrease their output supply (note that the model does not include optimal inventory behavior which, again, requires a fully dynamic setting). While this spillover effect is easy to capture, assumptions have to be made about a rationing rule when there is an excess labor demand. We assume an "efficient" rationing mechanism in which the excess of the marginal revenue product of the rationed labor category over its wage is equalized across sectors. This can be written as:

$$(1) \quad MRPL_{ki} = \gamma_k W_k$$

where  $k$  is the index of the rationed labor category  $MRPL_{ki}$  is the marginal revenue product of this labor category in sector  $i$ , and  $\gamma_k$  is the uniform "labor scarcity rate" or "labor premium" for labor category  $k$ . Note that this rationing rule is equivalent to those chosen in one-sector models such as that of Malinvaud (1977). Note, also, that any sector uses only one type of labor; therefore, no spillover effect is possible on the input side of the firm (since capital is immobile and intermediate inputs are required by a fixed-coefficients technology).

### C. Sectoral Price Rigidity

As stressed in section 2, price rigidities can come from government intervention or, for example, imperfect information and price setting by producers. We fix the price of the domestic good in certain sectors. When the prevailing price is too high, supply is rationed, leading to a decrease in labor demand

by this sector. In equilibrium, the marginal revenue product of labor exceeds the wage; and equation (1) is valid, but with a sector-specific labor premium rate,  $\gamma_i$ , replacing the labor-specific  $\gamma_k$ .<sup>8/</sup>

When the prevailing price is too low, demand has to be rationed. We assume consumer demand of households is then rationed. Given our Cobb-Douglas utility function, the constrained optimization yields a spillover effect in which all nonrationed budget shares (sectoral goods and savings) are increased proportionately. The two household categories (rural and urban) are assumed to be rationed equally (i.e., their actual/desired budget shares drop in the same proportion for each rationed good).<sup>9/</sup>

Given that consumers demand a composite good which is a mix of imports and domestic goods, there is scope for spillover effects from rationed domestic goods to imports. However, when the domestic price is fixed, we also assume that there is import rationing, at least partially blocking the spillover possibilities. Thus, for consumers, we assume that all of the spillover effect falls on nonrationed composite goods and on savings.<sup>10/</sup>

#### D. Overall Savings-Investment Balance

In the one-sector models discussed in the fixed-price literature, there is no difference between sectoral price rigidity and aggregate price rigidity. Output price rigidity leads to excess supply of goods or to forced savings, depending on whether the price level is too high or too low. In these models, as in traditional macromodels, real balances and/or the real interest rate can move so as to bring aggregate demand to the level of aggregate supply when prices are flexible. This is not true in CGE models where financial assets are not in the framework of analysis, where the model is homogeneous in all prices

and wages, and where there is no interest rate. In these models, even without any rigidities, a "closure problem" appears. There is no mechanism to ensure at the same time full employment and the equality between exogenous investment and Keynesian savings levels together with optimality conditions on employment decisions.<sup>11/</sup> In this case, several macro "closure rules" can be designed to achieve an investment-savings balance that is also the aggregate demand-supply equilibrium: a savings-driven closure (investment is residual), an investment-driven closure (public or private sector savings is residual), or a Keynesian closure (where aggregate output adapts in order to equate savings and investment). The idea is that aggregate prices may not move in such a way as to ensure overall equilibrium, at least in the short run. The problem with this approach is that the need for a closure rule results implicitly from the homogeneity of the model in all goods and factor prices, which are all the prices of the model but only a subset of prices in a real-world economy where financial assets are present. The substance of the closure problem, i.e., the possibility of savings-investment imbalance, goes beyond CGE models and is a major theme in macroeconomics.<sup>12/</sup>

We follow the fixed-price literature in assuming an exogenous amount of investment and, thus, run the model in investment-driven mode. This implies that we will not be able to analyze investment effects of the various shocks and rigidities. Instead, we concentrate on savings. Excess ex ante investment will lead to forced savings--the typical mechanism in fixed-price models. For the cases in which ex ante investment is "too low" or government savings are "too high," we will explore both the Keynesian closure (with rationing of

excess supply) in which a uniform labor premium rate--or ratio of marginal labor productivity over wages across sectors and labor categories--will emerge to ration supply and the "Ricardian equivalence hypothesis" (where households treat taxes and government deficits equivalently) in which demand will adjust ex ante to supply.

The mix of macroadjustment mechanisms in our model differs from those specified in earlier CGE models, although other models share some of the components. Lance Taylor, for example, has built a number of "structuralist" models, both aggregate macromodels and multisector CGE models, which are characterized by fixed aggregate investment and a fixed nominal wage.<sup>13/</sup> Savings-investment balance is achieved by what he calls "Keynesian closure" involving a multiplier mechanism. Changes in the real wage (achieved through changes in the aggregate price level given the fixed nominal wage) generate changes in output and, hence, income through changes in the demand for labor. Income (and, hence, output) settles at the level required to generate the savings needed to validate the exogenous investment. In this model, any contraction in output requires a rise in the real wage, with reduced employment, but with employed workers receiving above the market-clearing wage.

In our model, Keynesian closure leads to quite different behavior, with simultaneous rationing in both product and labor markets. In this case, with a fixed real wage, excess supply in the product market generates an increase in the labor premium as rationed firms cut back on output and labor demand. The result is Keynesian unemployment, but with no rise in the real wage of the employed.<sup>14/</sup> The labor premium accrues to firms, not to workers. In addition, this effect can operate sectorally, so it is possible to have Keynesian unemployment in some sectors but classical unemployment overall.<sup>15/</sup>

## V. Experiments: Description and Results

The comparative-statics experiments assume a fixed total capital stock and labor supply (for rural and urban labor). The numeraire (the overall price level) is also held constant as is total nominal investment (defining the investment-driven macroclosure).

Various rigidities are added sequentially. For the foreign exchange market, the nominal exchange rate is fixed with premium rationing clearing the market. For the labor markets, wages are fixed in real terms. Finally, for some sectors, domestic prices are fixed. There are three series of experiments, each with a different exogenous shock.

### A. Effects of a Decrease in Foreign Capital Inflow

The common shock in this series of experiments is a decrease of \$2 billion in foreign borrowing availability, representing 20 percent of total imports in the reference period:

#### Experiment

- A-1 Assumes flexibility of all sectoral prices and wages and of the exchange rate. At the aggregate level, savings is equated to investment through endogenous household savings rates (forced savings mechanism).
- A-2 Differs from (1) with respect to the foreign exchange regime. Here, the exchange rate is fixed and the foreign exchange market is cleared through premium rationing.
- A-3 Embodies the same hypotheses as in (2) but assumes a fixed real wage for the two categories of labor.
- A-4 Starts from (3) and adds a fixed domestic price in agriculture.
- A-5 Same hypotheses as in (4) but adds a fixed domestic price in the service sector.



Table 3 presents the basic results. The flexible exchange rate experiment is a good example of how a Walrasian model adjusts easily and costlessly to a shock, however large. The devaluation implied by foreign borrowing restrictions is dramatic: 55.2 percent. Note that we have assumed that there is no export response. Import prices increase sharply which--keeping the numeraire constant--implies a decline in domestic prices.

Having decreased one source of saving, there is an overall disequilibrium in the ex ante savings-investment balance. As a result, household consumption decreases, and forced household savings rates increase by 32 percent. At the sectoral level, the decrease of private consumption implies a drop in prices for agriculture, consumer goods, and services. The decrease in import availability drives up the prices of other sectors. Note that wages have to go down on average more than do domestic prices. The fall in absorption must lead to lower real incomes. The rural sector shares the burden because rural wages are driven down by the decrease in private consumption.

To summarize the results from Experiment A-1, given the assumption of full employment, aggregate production is largely unaffected, but there are dramatic changes in the price structure. Import prices rise by 50 percent on average while domestic prices fall by 3.5 percent on average, with significant changes in relative prices.

When we replace exchange rate flexibility with a fixed exchange rate and premium rationing, the premium rate jumps to 56.3 percent in Experiment A-2.<sup>16/</sup> This generates efficiency losses through rent seeking, and aggregate output goes down by almost 1.5 percent. In value terms there are larger consequences for value-added prices and for wages since full employment is maintained (nominal wages fall by 10 percent). Sectoral price trends are similar to Experiment A-1 even though, for the sector in which the efficiency losses are

TABLE 3  
Effects of a Decrease in Foreign Borrowing of \$2 Billion

	Changes compared to the reference period				
	Experiment				
	A-1	A-2	A-3	A-4	A-5
	percent				
<u>Output</u>					
Agriculture	0.06	- 0.68	- 8.03	-18.32	-23.86
Mining	6.96	4.09	0.42	- 1.35	-10.08
Consumer goods	2.41	- 0.34	- 3.92	- 6.34	-10.44
Other industries	1.49	- 1.79	- 4.11	- 4.40	- 9.93
Services	-1.24	- 2.43	- 6.22	- 7.02	-19.11
Sum	0.33	- 1.47	- 5.73	- 8.85	-16.73
<u>Employment</u>					
Agriculture	0.00	0.00	-12.36	-28.56	-36.74
Mining	8.21	7.54	2.69	0.27	-10.61
Consumer goods	6.80	0.80	- 8.57	-14.31	-22.79
Other industries	3.12	4.58	- 2.49	- 4.45	-18.06
Services	-2.73	- 1.62	- 9.11	-10.92	-30.47
Sum	0.00	0.00	-10.54	-21.46	-32.89
<u>Domestic prices</u>					
Agriculture	-6.45	- 6.71	- 4.98	0.00	0.00
Mining	-4.33	- 0.05	2.52	- 3.98	- 3.33
Consumer goods	-8.81	- 6.19	- 9.96	-16.42	-19.18
Other industries	5.41	7.65	4.77	- 2.67	-10.31
Services	-4.48	- 4.76	- 6.85	-13.20	0.00
Average	-3.45	- 2.66	- 4.25	- 8.26	- 5.26
<u>Nominal wages</u>					
Rural	-5.38	-10.80	- 2.88	- 6.25	- 3.51
Urban	-3.08	-10.38	- 2.94	- 6.51	- 3.34
Average	-4.49	-10.64	- 2.90	- 6.35	- 3.44

the highest (3.8 percent of production in other industries), there is a sharp difference between the employment effect (+4.6 percent) and the output effect (-1.8 percent). Note, finally, that the distributional effects of rent seeking, which lead to more money for firms and less for workers, increase the ex ante savings rate in the economy. The household forced savings rate is now only 15.9 percent above the corresponding desired rate compared to 32 percent in Experiment A-1.

When the sharp decrease in real wages is prevented by a fixed wage (Experiment A-3), the output and employment effects are dramatic. The combination of the exchange rate and wage rigidity is reinforcing. Rent seeking decreases efficiency and increases the need for lower real wages, increasing the negative employment consequences of fixed wages.

Macroeconomically, Experiment A-3 generates classical unemployment. In addition to high unemployment, household consumption is constrained by the need to match the investment target. Forced savings rates are now 52 percent higher than the desired rates.

The overall premium rationing rate is affected only slightly by the additional rigidities. The drop in output leads to lower import needs; but, on the other side, exports have also decreased given the fixed sectoral export ratios.<sup>17/</sup>

At the sectoral level, note the dramatic drop in agricultural output through fixed wages and constrained private consumption. In the two remaining experiments, sectoral price rigidities are introduced in agriculture and services. These two sectors are characterized by low import and export ratios and are typical examples of nontraded sectors. In both sectors, Experiment A-3 shows a decrease of domestic prices relative to the numeraire. We assume that

this decrease is not allowed to happen in the next two experiments. As a consequence, firms will be rationed on the goods market.

In Experiment A-4, price rigidity applies only to agriculture. The results of not allowing a drop of 5 percent in the agricultural price (sector 1) are a dramatic output effect (-18 percent instead of -8 percent in Experiment A-3) and employment effect (-28.5 percent instead of -12 percent in Experiment A-3). Note, however, that the effect on other sectors is small due partly to the fact that the agricultural labor market is separate from the urban labor market. There is no endogenous migration.

The economy as a whole is in classical unemployment. To meet the investment target, household savings rates are almost double (1.97 times) the desired rates. The agricultural sector is, however, in Keynesian unemployment. The marginal revenue product of labor is 22 percent above the fixed real wage, given output rationing and the fixed agricultural price. This labor premium accrues to farmers and arises from the combination of output rationing and the fixed real wage.

When the domestic price of services is not allowed to decrease (Experiment A-5), the overall drop of production and employment becomes huge. This is true, not only in the service sector (production falls by 19 percent and employment by 30 percent), but in the other sectors as well. The drop in output and employment in these two large sectors decreases demand for the others and so lowers their domestic prices. With fixed wages, this fall in prices depresses output in the flex-price sectors.

Experiment A-5 includes four types of disequilibria:

(1) The economy suffers from heavy unemployment. Note that these numbers could be compensated partly by a decrease in productivity. This is possible in

factors with Keynesian unemployment (agriculture and services), where significant labor premia can be shared if the labor force is organized well enough. However, heavy unemployment in the economy should weaken the bargaining power of labor.

(2) The economy as a whole is in classical unemployment, with overall demand being rationed. In Experiment A-5, household savings rates are more than twice (2.13) the desired rates. This is a consequence of the fixed investment target, which can be justified if investment is controlled by the government (as it is in several developing countries) or if the shock is perceived by private firms as temporary.

(3) The two fixed-price sectors are in Keynesian unemployment with labor premia rates of 25 percent in agriculture and 54 percent in services. Note that in this case the overall output and employment effects of these sectoral price rigidities are more important than they are for wage rigidities (in Table 3, compare Experiment A-5 to Experiment A-3). The combination of rigidities aggravates the problem. Labor market disequilibrium and savings-investment disequilibrium are reinforced with additional rigidities. The only disequilibrium for which this is not true is the foreign exchange shortage.<sup>18/</sup>

(4) The external disequilibrium is lowered somewhat in Experiments A-4 and A-5. The import premium rate is 42 percent and 33 percent in Experiments A-4 and A-5, respectively, compared to 52 percent in Experiment A-3. The lower rate in A-5 is due to the decrease in import needs following the fall in output (this effect outweighs the slight drop in exports).

#### B. Effects of a Lower Government Deficit

In this series of experiments, we analyze the effects of an exogenous increase in the government savings rate of 5 percentage points (from 57 percent

to 62 percent). This increase represents 5 percent of aggregate investment (including inventory accumulation) in the economy.

Two hypotheses are made concerning savings-investment equilibrium. In Experiments B-1, B-2, and B-3, we assume the Ricardo equivalence hypothesis of automatic private savings adjustment to the government deficit (see Barrow, 1974). Knowing that a lower current deficit means lower taxes in the future, private agents decrease their current savings rates. In Experiment B-4, we assume Keynesian closure. The excess of savings in the economy, given the assumption of wage rigidity, creates overall Keynesian unemployment.

In the first three experiments, rigidities are added successively. Experiment B-1 assumes that the exchange rate, prices, and wages are all flexible. Experiment B-2 introduces real wage fixity; and Experiment 3 adds sectoral price rigidity for all nonagricultural prices. Note that in these experiments we have assumed a flexible exchange rate and fixed sectoral export shares.<sup>19/</sup> The results are shown in Table 4. Experiment B-1 shows that the increase in government savings and the resulting decrease in household savings rates (by 16 percent) change the structure of demand in favor of agriculture (whose domestic price rises). The biggest drop in a sectoral domestic price is in services. Wages are also affected with a 2.3 percent increase in the rural-to-urban wage ratio.

Note, however, that these substantial changes in demand structure are met by supply adjustments through relatively small changes in prices and wages. There is also little change in the equilibrium exchange rate (with no rationing and no change in the structure of tariffs and subsidies). In a neoclassical world, this decrease in government consumption (by more than 10 percent) has little impact on prices, wages, and production. Without rigidities, aggregate

output is largely determined by aggregate capital and labor, with little impact from changes in sectoral structure.

Because in Experiment B-1 only small price and wage changes are necessary to maintain full employment and efficient production allocation, introducing rigidities can also be expected to have small consequences. Indeed, while in Experiment B-3 we have wage rigidity plus price rigidity in all but one sector, the drop in aggregate output and employment is only about 1 percent. The overall picture is, however, theoretically interesting. One labor category (urban workers) suffers from unemployment (around 3 percent in Experiment B-3) while the other (rural workers) is in a state of excess demand, with a labor premium rate of almost 1 percent. On the goods market, four sectors are in Keynesian unemployment: mining, consumer goods, other industry, and services (with labor premia rates of 1.0, 1.0, 7.0, and 5.0 percent, respectively).

Empirically, Experiment B-1 is not significantly different from Experiment B-3 although these experiments show some interesting theoretical features. This result would also hold if we tested the consequences of an increase in the investment target with rationing of private consumption or of any change in the structure of domestic demand. Experiment B-4 shows, however, that the assumptions on savings behavior or macroclosure are crucial for the outcome of the simulations. Experiment B-4 can best be compared with Experiment B-2. In both, the only rigidity considered concerns real wages, but the closure rule is different. Instead of the Ricardian equivalence hypothesis, Experiment B-4 assumes a Keynesian closure with exogenous investment and fixed savings rates out of disposable income. Total output and employment then have to adjust in order to eliminate the excess savings in the economy.

As shown in Table 4, in this case the choice of closure rule leads to dramatic differences in output and employment effects. The labor premium rate in the economy is 11 percent in Experiment B-4, and the economy is in an overall situation of Keynesian unemployment.<sup>20/</sup> This experiment is the standard Keynesian multiplier story (the multiplier, in our case, is around 3.0), and it has very different consequences from a world where private saving adjusts automatically in order to offset government deficit policies.

It is worth stressing that this shock has little impact on the external equilibrium in the economy, at least when private saving adjusts in order to eliminate the overall savings-investment imbalance. Contrast this result with Experiment B-4, where there the equilibrium exchange rate differs from the reference case by 10 percent. This change also has consequences for the price structure, which is altered much more in Experiment B-4 than in Experiment B-2. A general result of our simulations is that a shock affecting external equilibrium will exacerbate the differences between a flex-price economy and a fixed-price economy.

### C. Effects of an Increase in Real Wages

The first two shocks (changes in foreign borrowing and in the government saving rate) did not directly concern relative prices and were first tested in a Walrasian world where all prices are flexible. Since 1973, large relative price shocks have occurred in many countries arising from the oil price shock, exchange rate instability, and sectoral inflation differentials. With this background, our last shock involves relative prices directly. We analyze the effects of an exogenous 10 percent increase in real wages (not backed by productivity increases) in a world of wage rigidity.



TABLE 4  
Effects of a Decrease in Government Deficit

	Changes compared to the reference period			
	Experiment			
	B-1	B-2	B-3	B-4
	percent			
<u>Output</u>				
Agriculture	0.06	0.06	0.06	- 7.16
Mining	0.75	0.84	-1.05	- 5.10
Consumer goods	0.52	0.39	-0.01	- 3.87
Other industries	0.54	0.50	-0.92	- 2.97
Services	-0.10	-0.33	-1.69	- 4.29
Sum	0.19	0.07	-0.86	- 4.60
<u>Employment</u>				
Agriculture	0.00	0.00	0.00	-11.97
Mining	0.70	0.81	-1.46	- 6.24
Consumer goods	1.28	0.92	-0.20	- 9.94
Other industries	0.50	0.39	-3.33	- 8.34
Services	-0.45	-0.93	-3.63	- 8.51
Sum	0.00	-0.15	-1.15	-10.69
<u>Domestic prices</u>				
Agriculture	0.85	0.81	0.24	2.83
Mining	-1.59	-1.35	0.00	3.69
Consumer goods	-0.30	-0.25	0.00	- 2.41
Other industries	-1.16	-0.93	0.00	- 4.15
Services	-1.81	-1.84	0.00	- 2.37
Average	-0.82	-0.78	0.06	- 1.49
<u>Nominal wages</u>				
Rural	1.61	-0.61	-0.04	- 1.49
Urban	-0.75	-0.57	0.04	- 1.55
Average	0.71	-0.59	-0.01	- 1.51
<u>Other indicators</u>				
Exchange rate	-0.71	-0.89	-2.04	-9.12
Household savings rate	-16.00	-18.00	-20.00	0.00

Three experiments were designed, all under a flexible exchange rate regime. Experiment C-1 does not assume any sectoral price rigidity, Experiment C-2 adds agricultural domestic price rigidity, and Experiment C-3 adds to the hypotheses of Experiment C-2 domestic price rigidity in the service sector. In all three regimes, a shortage of savings will appear compared to the nominal investment target. Consumption will then be rationed, and household saving rates will adjust endogenously using the "forced savings" closure. The results are given in Table 5.

Experiment C-1 shows that real wage rigidity is responsible in this case for a loss of output of more than 4 percent (for employment, it is more than 10 percent). The economy as a whole is in classical unemployment with actual household savings rates higher than the desired rates by 33 percent. On the foreign exchange market, lower import needs owing to lower production more than outweigh the loss of exports (given fixed sectoral export coefficients). The equilibrium exchange rate falls (revalues) by about 4 percent.

As with the first shock, we have assumed sectoral price rigidities in the two sectors where the importance of external trade is the lowest, agriculture and services (see Table 1). When that is done in agriculture alone, in Experiment C-2, aggregate output drops another 0.81 percentage points. When we look at agricultural output, the decrease is dramatic--especially when one looks at the small price decrease (prices were up only 1.74 percent in Experiment C-1). Note, however, that the drop in the value-added price is 2.5 percent; moreover, the rationing of agricultural consumption (because now the price is too low) has increased demand and, hence, prices for the other goods (see Tables 5 and 6), so the relative price of agriculture falls. This spillover increases nominal wages in agriculture by another 1.80 percentage points

TABLE 5

Effects of an Increase of 10 Percent in Real Wages

	Changes compared to the reference period		
	Experiment		
	C-1	C-2	C-3
	percent		
<u>Output</u>			
Agriculture	- 7.24	-12.66	-12.50
Mining	- 4.81	- 4.46	- 3.34
Consumer goods	- 3.43	- 2.03	- 1.36
Other industries	- 2.60	- 2.56	- 2.17
Services	- 3.49	- 2.98	- 3.68
Sum	- 4.17	- 4.98	- 5.00
<u>Employment</u>			
Agriculture	-12.10	-20.67	-20.42
Mining	- 5.90	- 5.49	- 4.17
Consumer goods	- 8.91	- 5.49	- 3.79
Other industries	- 7.46	- 7.39	- 6.43
Services	- 7.05	- 6.09	- 7.39
Sum	-10.28	-15.09	-15.09
<u>Domestic prices</u>			
Agriculture	1.74	0.00	0.00
Mining	2.81	4.95	5.06
Consumer goods	- 3.35	0.24	1.54
Other industries	- 3.24	- 1.15	- 0.46
Services	- 1.63	1.26	0.00
Average	- 1.41	0.34	0.21
<u>Nominal wages</u>			
Rural	8.55	10.35	10.26
Urban	8.45	10.41	10.38
Average	8.51	10.38	10.31
<u>Other indicators</u>			
Exchange rate	- 4.42	- 1.77	- 0.89
Household savings rate	31.36	16.91	18.06

TABLE 6  
Consumption Rationing After an Increase of  
10 Percent in Real Wages

	Reference period	Experiment		
		C-1	C-2	C-3
<u>Consumption shares</u>				
Agriculture	28.00	28.00	24.73	24.85
Mining	0.30	0.30	0.31	0.32
Consumer goods	20.90	20.90	21.85	22.45
Other industries	13.80	13.80	14.43	14.83
Services	37.00	37.00	38.68	37.54
Sum	100.00	100.00	100.00	100.00
Savings rate	6.92	9.09	8.09	8.17

in order to maintain a constant rural real wage. The net effect is a drop in output of an additional 5.42 percentage points compared to Experiment C-1.

In the previous two shocks, relative price rigidities led to Keynesian unemployment at the sectoral level. Here it leads to demand rationing because a rise in the domestic price is prevented. Note that in this case the consequences at the aggregate level are not as bad. In the other two shocks, Keynesian unemployment in one sector depressed output in the other sector as well; here, due to consumer's constrained optimization, it leads to higher demand, prices, and output in the other sectors (see Table 5). Moreover, in Experiment C-2, because there is a redistribution of resources from agriculture to the other sectors, it increases the ex ante savings rate of the economy and lowers the need for forced savings (the actual rates for households are now only 17 percent higher than the desired savings rates instead of 31 percent in Experiment C-1). In this case, the added price rigidity (which creates a bigger disequilibrium in agriculture for both the output and labor markets) decreases the disequilibria in the rest of the economy--the unemployment rate of urban labor and the degree of forced savings in the economy. There is also less effect on the equilibrium exchange rate than in C-1. Note that the economy is still in overall classical unemployment with one sector having a higher degree of rationing than the others.

Experiment C-3 basically strengthens the mechanisms working in Experiment C-2. Here, again, the added price rigidity is favorable to the other sectors. The additional effect on aggregate output compared to C-2 is almost zero; and the unemployment rate among urban workers remains constant, labor having been reallocated from services to the other nonagricultural sectors. The forced savings rate is almost unaffected by the additional rigidity (18 percent of

forced savings instead of 17 percent in C-2), and there is also little effect on the equilibrium exchange rate (less than a percentage point change from C-2).

## VI. Conclusion

We have considered four types of rigidities: Exchange rate rigidities leading to premium rationing and rent seeking, wage rigidities leading to unemployment or labor scarcity, investment-savings imbalance leading to rationing of private consumption or to overall Keynesian unemployment, and sectoral price rigidity leading to consumption rationing or rationing of supply. The numerical results yield several lessons.

Not surprisingly, price rigidities are most damaging when a shock necessitates large relative price changes in a Walrasian world. Specifically, a change in the structure of domestic demand requires less relative price change than does a balance-of-payments disequilibrium or a "wrong" wage level. These results are consistent with actual experience. The international instability of the post-Bretton Woods era in a world of price and wage rigidities has led to severe adjustment problems. These problems have been much worse than the earlier adjustment associated with the postwar trend of the expansion of government expenditure as a share of gross domestic product.

The introduction of rigidity generates additional pressure for a change in the relative price structure in the rest of the economy. For example, in our experiments, rent seeking implied by a fixed exchange rate increases the need for a drop in real wages. Forced savings in the case of a drop in output changes the composition of demand and relative prices (when they are flexible).

Empirically, price rigidities are much more harmful when they lead to situations of excess supply than when they lead to situations of excess demand. On the labor market, labor scarcity is similar to the Walrasian solution in terms of aggregate production. In spite of increased incentive distortions, major output losses do not occur in experiments with price rigidities unless a situation of unemployment exists .

As far as savings-investment equilibrium is concerned, excess investment leading to rationing of private consumption (or a decrease in real wages) will change slightly the structure of demand but not lead to output and employment losses. However, any shock that generates excess saving in a Keynesian world with wage rigidity leads to major unemployment and lower output.

Finally, we have seen that sectoral price rigidity is worse in terms of aggregate production when it leads to excess supply rather than to excess demand. When there is excess demand, consumption rationing in the fixed-price sector leads to demand spillovers and, hence, to increases in demand in the other sectors. The net effect is that aggregate demand does not change much, so that there is little effect on macroeconomic balance.

Footnotes

<sup>1</sup>For surveys of this work, see Shoven and Whalley (1984) and Dervis, de Melo, and Robinson (1982).

<sup>2</sup>Multisector models have been used in the fixed-price literature only for proof of existence; see Drèze (1975); Bénassy (1975).

<sup>3</sup>For example, see Taylor (1983).

<sup>4</sup>Starting with Clower (1965), Patinkin (1965), Leijonhufvud (1968), Barro and Grossman (1971), and formalized in a multisector framework by Drèze (1975) and Bénassy (1975).

<sup>5</sup>Search models can provide answers to this problem (see examples in Phelps, 1970), but the results depend strongly on the particular assumptions made whenever the assumption of a centralized auctioneer is dropped. Diamond (1982), for example, builds such a model which exhibits many "natural" rates of unemployment.

<sup>6</sup>See Dervis, de Melo, and Robinson (1982), chapter 7, for a discussion of alternative treatments of export behavior and of the treatment of international trade in general.

<sup>7</sup>For a discussion of incorporating rent seeking in CGE models, see Dervis, de Melo, and Robinson (1982), pages 305-309,

<sup>8</sup>The model does not include any significant spillover effect toward export supply. There is no "vent for surplus" export mechanism. Note, however, that export ratios are quite low, especially in agriculture, other industries, and services (see Table 1). Allowing for an export spillover will change the nature of the empirical results in only one specific case as noted below.



<sup>9</sup>This seems to be a manipulatable rationing scheme in which households would have an interest in overstating their preferences for the rationed goods. However, we consider this specification as describing an aggregate ex post result. It is not a story about how the rationing mechanism works at the level of individual agents.

<sup>10</sup>An alternative specification would be to fix the composite-good price. This approach, however, raises problems about spillovers on the supply side. Both specifications have theoretical blemishes, but the differences should be of little empirical consequence.

<sup>11</sup>See Bruno (1979); Rattso (1982); Lysy (1982); Robinson (1983); Taylor (1983); Robinson and Tyson (1984); and Dewatripont and Michel (1985).

<sup>12</sup>For example, see Tobin (1980, Chapter 1) for a good summary of important elements of this discussion. Lewis (1985) has developed a CGE model incorporating two assets--bonds, and money--and uses it to explore some of these macroclosure issues.

<sup>13</sup>These structuralist models sometimes also include markup pricing rules; see Taylor (1979). Lysy (1982) provides a good survey.

<sup>14</sup>The difference between the behavior of real wages distinguishes our version of Keynesian closure from that of Lysy and Taylor. Our approach is in the spirit of the approach of Muellbauer and Portes (1978). Which one better reflects the thinking of Keynes is a debate we will leave to others.

<sup>15</sup>In this case the "labor premium" rate is sector specific.

<sup>16</sup>Note that the equilibrium premium rate is about the same as the required devaluation in Experiment A-1. If Experiment A-1 had allowed an export response, the devaluation would have been about half as large, and half the gap would have been met by increased exports.

<sup>17</sup>Given a fixed exchange rate, even if exporters were price sensitive, they would see no price change.

<sup>18</sup>The lack of interaction between savings-investment balance and the foreign exchange market is due to the fact that the balance of trade and, hence, foreign savings are fixed exogenously. A model with endogenous foreign borrowing would behave very differently.

<sup>19</sup>The addition of an export spillover effect when domestic output supply is rationed should, however, matter for Experiment B-4.

<sup>20</sup>Note that we did not introduce additional relative price rigidities into Experiment B-4 because of the difficulty of specifying realistic sectoral rationing rules in a situation of general Keynesian unemployment.

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