IMF WORKING PAPER

WP/90/2

INTERNATIONAL MONETARY FUND

Research Department

Financial Market Integration and Exchange Rate Policy 1/

Prepared by Donald J. Mathieson
and Liliana Rojas-Suarez

January 1990

Abstract

This paper examines how a country's exchange rate policy should be adjusted when the degree of integration between domestic and external financial markets increases as a result of both domestic financial liberalization and the relaxation of capital controls. As the financial structure is opened and liberalized, the optimal scale of exchange market intervention changes as the relative importance of different domestic and foreign shocks for output and price stability is altered. Nonetheless, the response of the optimal degree of intervention to increases in the variances of the various domestic and foreign shocks is similar across all financial structures.

JEL Classification No.:
431

1/ The paper was presented at the conference on "Exchange Rate Policies in Selected Industrialized Countries," Brussels, October 12-14, 1989, and will be published in the proceedings of the Conference. This paper has benefited from comments by Giorgio Basevi, Morris Goldstein, Peter Isard, and Timothy Lane, although they are naturally not responsible for any remaining errors. The views presented here are those of the authors and do not necessarily represent the position of the Fund.

Table of Contents

Appendices

Summary

This paper examines the issue of how a country's exchange rate arrangements should be adjusted when the degree of integration between domestic and external financial markets increases as a result of both domestic financial liberalization and the relaxation of capital controls. The exchange rate arrangements that best insulate the economy from domestic and foreign real and financial market shocks are analyzed under three alternative assumptions about the economy's financial structure: (1) when the economy has highly restrictive capital controls and places extensive restrictions on the domestic financial system; (2) when the authorities undertake a partial liberalization of domestic interest rates and the removal of some capital controls; and (3) when there is a complete removal of capital controls and the elimination of all restrictions on domestic interest rates.

Our analysis indicates that the removal of capital controls and liberalization of the economy affect exchange rate policy both by broadening the set of shocks affecting the economy and by altering the nature of the impact of a given shock on domestic output and prices. While the optimal scale of exchange market intervention can vary with the nature of the economy's financial structure, there is nonetheless a similarity in the response of the optimal degree of intervention to increases in the variance of the various domestic and foreign shocks across all financial structures, as long as the authorities' basic price or output stability objective remains unchanged. In addition, our analysis indicates that the combination of domestic financial liberalization and the removal of capital controls would not in general create a preference for one particular type of exchange rate arrangement. The optimal change in exchange rate arrangements would reflect both the changes in the financial structure of the economy as liberalization takes place and the relative sizes of the various shocks that impinge on the economy. Finally, our analysis indicates that the extent of the changes in optimal exchange rate arrangements that would occur as financial liberalization takes place would be strongly influenced by the nature of the terms and conditions under which domestic borrowers can access international financial markets. These terms and conditions would reflect both the nature of the country's capital controls and the decisions of international lenders regarding the creditworthiness of domestic borrowers. As a liberalization proceeds, creditworthiness considerations would replace official restrictions as the key limitation on market access. This also implies that shifts in market perceptions of the creditworthiness of a country's borrowers could imply a sharp change in the nature of a country's optimal exchange rate arrangements, especially if this change in perceptions leads to the imposition of credit rationing.

I. Introduction

One of the major structural changes in the international economy during the past two decades has been the growing integration of capital markets in the industrial countries. This integration has reflected both the dismantling of capital controls and the removal of restrictions that have limited competition or asset price flexibility in domestic financial markets. The extensive liberalization of restrictions on cross-border financial transactions, in particular, stands in sharp contrast to the limited progress (or, in some cases, regression) that has been evident in reducing barriers to trade in goods and services.

As restrictions on domestic and external financial transactions have been lowered, financial markets have helped magnify the short-run spillover effects of domestic macroeconomic policies on neighboring countries. At the same time, the institutional changes brought about by financial liberalization may have weakened the authorities' ability to respond to those spillover effects. In particular, questions have been raised about whether the effectiveness of traditional macroeconomic policy instruments has been reduced, whether exchange rate arrangements and intervention strategies need to be altered, and whether the coordination of macroeconomic policies among the major countries needs to be increased.

This paper examines one aspect of these policy issues--namely how should a country's exchange rate policy be adjusted when the degree of integration between domestic and external financial markets increases as a result of both domestic financial liberalization and the relaxation of capital controls. 1/ It is interesting to note that rather different approaches for solving this policy problem are being adopted in Europe and North America. The Delors Report (1989) has recommended that, in order for the members of the European Monetary System (EMS) to enjoy the full benefits of financial market integration, they should maintain a system of relatively fixed exchange rates between themselves. 2/ In contrast, although the United States-Canada Free Trade Agreement contains provisions which significantly reduce or eliminate barriers to financial transactions between residents of the two countries, the Canadian authorities seem committed to a relatively flexible exchange rate policy vis-à-vis the United States and other countries. These different approaches leave unanswered the question of what exchange rate arrangements should be adopted by countries on the "periphery" of these large trading blocs, especially if these peripheral countries are also planning to reduce their capital controls and undertake domestic financial reforms.

1/ While it is generally accepted that optimal exchange rate arrangements depend on the policy objective function, the structural characteristics of the economy, and the relative importance of different types of shocks, this paper emphasizes that the degree of integration between domestic and external financial markets is an important sstructural characteristic in this context.

2/ For an analysis of exchange rate determination in the EMS, see Basevi (1982).

Our analysis of the relationship between financial liberalization and exchange rate policy is divided into four sections. Section II briefly considers how the recent changes in capital controls and domestic financial regulations in the industrial countries have altered the terms and conditions under which borrowers can obtain funds from domestic and external financial markets. Section III develops a relatively simple model of real and financial sector linkages in an open economy that is used to provide a framework for analyzing how the changes in financial structure induced by the removal of capital controls and the liberalization of domestic financial market restrictions can influence optimal exchange rate arrangements. In this model, a financial constraint arises from the assumption that firms use credit from commercial banks to finance their working capital needs prior to the sale of their output. 1/

In Section IV, this model is used to identify the exchange rate arrangements that best insulate the economy from domestic and foreign real and financial market shocks under three alternative assumptions about the economy's financial structure: (1) when the economy has highly restrictive capital controls and places extensive restrictions on the domestic financial system; (2) when the authorities undertake a partial liberalization of domestic interest rates and the removal of some capital controls; and (3) when there is a complete removal of capital controls and the elimination of all restrictions on domestic interest rates. 2/ To examine the role of creditworthiness considerations in influencing exchange rate arrangements, cases (2) and (3) are analyzed in the situations where international lenders either do or do not find it profitable to credit ration domestic borrowers. Two important results are obtained. First, as the economy's financial structure is opened and liberalized the optimal scale of exchange rate intervention will change as the relative importance of different domestic and foreign shocks for output and price stability is altered. Moreover, although the optimal scale of exchange market intervention can vary with the financial structure, there is nonetheless a similarity in the response of the optimal degree of intervention to increases in the variances of domestic and foreign shocks across all financial structures. The final section of the paper summarizes our main conclusions and considers certain unresolved issues.

1/ For some evidence on the effects of the availability of real credit on output in the United States, see Calomiris and Hubbard (1989).

2/ For simplification purposes, we take the authorities' decision regarding the liberalization of domestic and external financial transactions as exogenous to our analysis of exchange rate policy. In a more general analysis, the sequencing of financial reforms and exchange rate policy would be determined simultaneously and would be designed to achieve the authorities' overall efficiency and stability objectives. The model could be used, however, to analyze these issues given some assumptions about the authorities' overall objective function.

II. Liberalization and Structural Change in Major Financial Markets

Since the mid-1970s, the authorities in industrial countries have eliminated or weakened many of their restrictions on external and domestic financial transactions. 1/ This liberalization of financial activities has reflected both the desire to produce greater competition and efficiency in domestic financial markets and a recognition that many large financial and nonfinancial institutions were increasingly turning toward the less regulated offshore markets to meet their financial needs. Although the specific financial liberalization measures have naturally differed across countries, there have been several common features: the elimination of barriers to market access; the removal of restrictions on the activities, products, and location of financial institutions; and greater reliance on market determined interest rates.

In the early 1970s, barriers to market access encompassed both capital controls limiting trade between domestic and external financial markets and limitations on domestic residents' use of certain domestic markets. Capital controls and limitations on entry of foreign financial institutions into the domestic market 2/ were part of the effort to isolate domestic financial systems from external developments. The limitations on access to certain domestic markets by domestic residents were typically designed to help protect specialized institutions or to prevent certain financial policies from being circumvented. 3/ Although the lowering of restrictions on participation of foreign financial firms has often intensified competitive pressures in domestic markets, the removal of capital controls has been the most important change in the barriers to market access in many countries. 4/

1/ More detailed analyses of these changes can be found in Bryant (1987) and Folkerts-Landau and Mathieson (1988).

2/ The entry of foreign financial institutions was often limited through controls on chartering and licensing, through restrictions on the activities that these institutions could undertake, and through constraints on their use of certain domestic markets.

3/ For example, the access of households to short-term money market instruments (particularly Treasury securities) was often limited to prevent an outflow of funds from banks or other specialized institutions as market interest rate rose relative to ceiling deposit rates.

4/ By 1974, the United States had removed various administrative guidelines imposed during the 1960s that inhibited foreign access to U.S. financial markets or curtailed foreign lending by U.S. financial institutions. The United Kingdom removed its capital controls on cross-border sterling transactions in 1979. During the late 1970s, the German authorities progressively removed the restrictions on capital inflows (e.g., limitations on the payment of interest on bank deposits held by foreigners), that had been introduced in the period surrounding the collapse of the Bretton Woods exchange rate system in the early 1970s. Since the early 1980s, the Japanese authorities extensively liberalized their restrictions on cross-border financial activities and allowed foreign financial institutions increased access to Japanese markets. Moreover, members of the European Economic Community have also pledged to remove their remaining capital controls in 1990.

Restrictions on the activities, products, and location of financial institutions were often used to complement and reinforce the barriers to market access. Commercial and investment banking activities were separated in some countries partially due to concerns about minimizing the risks accepted by the commercial banking system. Limitations on the types of instruments that could be issued by certain institutions were also designed to enable other more specialized institutions to have adequate access to funds. The erosion of these restrictions has been most evident in those countries where a separation of commercial and investment banking has been maintained by law. 1/

While ceilings on interest rates were employed in almost all industrial countries in the period up to the 1970s, there was a growing recognition that such ceilings could seriously interfere with the financial intermediation process, especially when inflation rates were rising and controlled interest rates were adjusted slowly. In particular, increases in market interest relative to prevailing ceiling interest rates on deposits could lead to a sudden withdrawal of deposits from certain institutions. Unless the borrowers from these institutions could find other sources of funds, their access to investment financing could be sharply and suddenly curtailed.

Interest rate deregulation has proceeded at divergent rates in the major industrial countries. While interest controls were effectively removed in the mid-1960s in the Federal Republic of Germany, Regulation Q ceiling interest rates in the United States were phased out in the early

---

1/ In the United States, the Glass-Steagall Act, which was part of the Banking Act of 1933, separated commercial and investment banking by barring Federal Reserve member banks from underwriting or dealing in most securities and by barring securities houses from accepting deposits. Throughout the 1970s and 1980s, however, U.S. commercial banks engaged in securities activities outside the United States and expanded their domestic securities activities in areas not prohibited by Glass-Steagall (e.g., placing commercial paper and underwriting general obligation government securities). Moreover, in 1987, the Federal Reserve approved the application of several bank holding companies to engage in limited securities activities through subsidiaries not "principally engaged" in these activities. At the same time, securities firms, insurance companies and other nonbank financial firms have been offering banking services through limited service or "nonbank" banks.

In Japan, Article 65 of the Securities and Exchange Law (enacted in 1948) prohibited banks from engaging in the securities business, although there were exceptions for certain types of government bonds. During the 1970s and 1980s, banks increased their securities activities by supplying financial products and transaction services linked to government bonds. The securities houses, in turn, developed new linkages with some of the credit-cooperative (shinkin) banks that allowed individuals to transfer freely between medium-term government bond funds (chukoku) and ordinary deposits.

1980s. In Japan, the process of interest rate deregulation is still underway. The Japanese authorities have followed a program involving the introduction of new deposit instruments (e.g., money market certificates) carrying market-related interest rates with a continuing decline in the minimum issuance size for these instruments. Nonetheless, the interest rates on small bank deposits and postal savings deposits remain subject to controls.

This process of liberalization has fundamentally altered the financial structures of the major industrial countries and has forged new linkages between the financial markets in these countries. Increased competition has forced many financial entities to re-examine the range of financial services and products that they can profitably produce. The competition for new customers has often involved the creation of new financial products and services. While many of these innovations quickly pass from the scene, this competition has greatly facilitated the efforts of portfolio managers to achieve an internationally diversified portfolio and the search of corporate (and sovereign) treasurers for the lowest cost source of funds.

Despite the removal of capital controls and the liberalization of domestic financial markets, however, different categories of borrowers still often face divergent terms and conditions under which they can access foreign and domestic sources of funds. Access to borrowed funds is typically affected both by official restrictions on market access (including capital controls) and by the lenders' evaluation of the borrowers's creditworthiness. The liberalization measures undertaken in recent years imply that, to an important degree, creditworthiness considerations have now replaced capital controls and other official restrictions on market access as the principal limitation on an individual borrower's access to funds. Creditworthiness considerations affect both the cost of borrowing (due to the presence of a premium reflecting default risk) and the availability of funds. In particular, access to some markets may be curtailed for certain classes of borrowers even in the absence of government restrictions. For example, only sovereign and large corporate borrowers which are regarded as good credit risks can issue on the Eurobond markets. Thus, while most borrowers can now seek funds from a broader range of domestic and international institutions than in the pre-reform period, the "small-country" assumption that they can borrow unlimited amounts at a fixed international interest rate would not be an appropriate characterization of the terms and conditions under which most borrowers can access international markets.

The presence of such market imposed limitations on the availability of funds is not inconsistent with the evidence that covered interest rate differentials have been arbitraged away on comparable short-term instruments and sharply narrowed on equivalent medium and long-term instruments. 1/ The elimination of covered interest rate differentials indicates that a borrower with a given credit rating can obtain funds at a cost that is identical across markets in different countries and when using instruments denominated in different currencies. Nonetheless, this does not rule out the fact that borrowers with different credit ratings must pay different risk premiums; nor is it inconsistent with the fact that as the amount of debt issued by a single borrower increases, lenders would typically become more concerned about the borrower's ability or willingness to pay. While these concerns would be reflected in higher borrowing costs, the lender may strictly limit the availability of funds to a borrower when the expected profit on an additional dollar of lending (even at a higher interest rate) is reduced to zero because the probability of default would be increased sufficiently to offset the higher interest income associated with the additional lending.

Whether such "equilibrium" credit rationing is a valid characterization of the situation confronting borrowers on international markets is open to debate. 2/ Even if credit rationing was evident, it is unlikely that all borrowers would face the same degree of rationing. Nonetheless, the nature of the terms and conditions under which domestic borrowers can access international markets are factors that could have a strong bearing on the degree of exchange market intervention that would best stabilize domestic income or prices as a country undertakes a financial liberalization and opens to external financial transactions.

III. Basic Model

To identify the exchange rate policy that would impart the greatest stability to either domestic output or the price level in the face of various domestic and foreign shocks as domestic financial restrictions (e.g., interest rate ceilings) and controls on international capital flows are removed, this section develops a simple model which incorporates crucial linkages between real activity, domestic financial intermediation, and external financial and goods markets. What ideally is needed to analyze this policy issue is a multicountry model of large economies that specifies the linkages between the real and financial sectors both within and across countries. As the complexities involved in developing such models are well known, we have a much more modest first objective of focusing on the linkages between the real and financial sector in a single open country and considering how changes in those linkages affect exchange rate policy. Our model, therefore, necessarily abstracts from many of the complex real and financial sector linkages that exist in a modern industrial economy. Moreover, since our focus is on the design of exchange rate policy, we do not explicitly consider the case where the

---

1/ Covered differentials may remain where different instruments are subject to different tax or regulatory considerations, or even where expected furture tax rates differ (see Dooley and Isard (1987)).

2/ See Stiglitz and Weiss (1981) for a further discussion.

authorities have decided to commit to a fixed exchange rate arrangement (such as the EMS) and use other policy instruments (e.g., the required reserve ratio) to stabilize the economy. However, the model could be used to analyze this situation.

1. <u>General framework</u>

The economy that we analyze consists of three sectors: firms, households, and banks. 1/ Firms are owned by entrepreneurs who produce a single tradable good using their own capital and the labor services provided by workers from the household sector. The entrepreneur's objective is to maximize the expected discounted value of the utility of his consumption over time. Entrepreneurs also borrow from banks to finance their payments of wages prior to the sale of their output. This short-term working capital borrowing must be repaid to the bank, with interest, after the entrepreneur's output is sold. The firm's profits are used to purchase investment goods and the entrepreneur's consumption. Each firm's output is assumed to be subject to an exogenous production shock, so there is some probability that the entrepreneur will be unable to service his debt obligations. 2/

Banks accept deposits from households, acquire funds from abroad (subject to the limitations imposed by capital controls), make loans to firms, and attempt to maximize expected profits. The banks are assumed to recognize that, since firms are subject to random production shocks, some entrepreneurs may default on their loan obligations. This risk leads the banks to evaluate the loan applications of each firm ex ante (to understand the firm's investment plans and its vulnerability to production shocks) and also to monitor any reported defaults ex post (to ensure truthfulness). The possibility of default implies the banks might engage in equilibrium credit rationing (i.e., they may at some point refuse to lend more to a firm even if it offers to pay a higher interest rate). Such credit rationing arises when the bank perceives that additional lending raises the expected loss of revenue through default by more than the expected gain in revenue associated with the higher interest rate.

When domestic banks are allowed to borrow abroad, international lenders are assumed to recognize that the domestic banks will use the external funds they obtain to make loans to domestic firms. The international creditworthiness of domestic banks is therefore evaluated in terms of the probability that the banks' domestic customers would be able

---

1/ This model is based on that developed in Isard, Mathieson, and Rojas-Suarez (1989). A similar model that abstracts from credit rationing is contained in Rojas-Suarez (1987).

2/ If the firm's revenue falls short of its debt obligations, the entrepreneur must transfer his capital to his creditors, and the firm ceases to exist.

to service their debts. 1/ As a result, the international lenders would add a default risk premium to the risk-free international interest rate in order to determine the loan rate charged domestic banks. While this risk premium would rise as the amount of borrowing by domestic banks increased, the international lenders might also engage in equilibrium credit rationing of the domestic banks.

Households use their income, from providing labor services and from interest earned on their deposits with banks and foreign assets, to finance their consumption and to increase their holdings of domestic deposits and foreign assets. 2/ They attempt to maximize the expected discounted value of their utility over time, which depends positively on consumption and negatively on labor effort. When capital controls are removed and households can hold foreign assets, households adjust their holdings of domestic deposits and foreign assets so as to equate the expected risk-adjusted yields on the two instruments.

The authorities are assumed to affect domestic behavior through three channels: the establishment of capital controls which limit external financial transactions, the impositions of restrictions on the domestic financial system, and the formulation of exchange rate policy. As already noted, our analysis considers the cases where capital controls either effectively eliminate external financial transactions, or allow to domestic banks limited access to international markets, or are totally removed. The effects of restrictions on the domestic financial system are examined in terms of the presence or absence of ceiling loan and deposit interest rates. Monetary and exchange rate policy are linked via an exchange market intervention function which relates changes in the domestic stock of base money to exchange rate movements.

Exchange rate policy is analyzed under three alternative assumptions about the economy's financial structure. In the first case, it is assumed that the economy is closed to external financial transactions through the use of effective capital controls and has a domestic financial system that is constrained by official interest rate ceilings (on banks' loan and deposit interest rates) and high required reserve ratios. Domestic borrowers are therefore faced with "disequilibrium" credit rationing in the sense that the demand for credit at the ceiling interest rates exceeds the available supply and the interest rate charged borrowers does not appropriately reflect the opportunity cost of borrowed funds.

The second case that is examined is an economy with a partially opened and liberalized financial system in which domestic banks are allowed to borrow abroad (subject to certain limitations) and the domestic

---

1/ This abstracts from the possibility that domestic banks might have reserves available to cover customer defaults or that the government might implicitly or explicitly guarantee the banks' external debts.

2/ Households are assumed to hold domestic money only in the form of bank deposits.

loan rate is freed from official controls. However, the domestic deposit rate is still subject to an official ceiling, and capital controls are assumed to prevent domestic depositors from moving their funds abroad. 1/ While this partial removal of capital controls allows domestic banks access to international markets, the markets' evaluation of the domestic borrower's creditworthiness is a crucial determinant of the nature of this access. To analyze the role of creditworthiness considerations, the optimal exchange rate arrangements for a partially liberalized economy are examined both when domestic borrowers are credit rationed by foreign lenders (i.e., they would like to borrow more at prevailing international interest rates but cannot) and when domestic borrowers are not credit rationed. If "equilibrium" credit rationing exists, it would reflect the profit maximizing decisions of lenders rather than any official restriction or constraint.

In the third case, the formulation of exchange rate policy is considered for a completely open and liberalized domestic financial system in which all capital controls and domestic interest rate ceilings have been removed. Once again, however, domestic borrowers may or may not be subjected to "equilibrium" credit rationing by international lenders.

It should be stressed that our analysis of the design of exchange rate policy is focused on the issue of what exchange rate arrangements would over time stabilize output or prices rather than what type of short-term exchange market intervention would best offset a specific shock. As a result, our concern is on the effects of alternative exchange rate arrangements on the equilibrium levels of output, prices, and interest rates that will prevail in the face of different patterns of foreign and domestic shocks.

2. Structural relationships

The economic structure described above can be represented by the following set of relationships:

$$(1a)\quad y^s_t = \bar{y} + \mu_0 + \mu_1 (b^s_t - p_t) + \mu_2 (r_{m,t} - Ep_{t+1} + p_t) + n_t$$

(under credit rationing)

$$(1b)\quad y^s_t = \bar{y} + \mu_3 - \mu_4 r_{bt} + \mu_5 (r_{m,t} - Ep_{t+1} + p_t) + n_t$$

(without credit rationing)

1/ Our analysis also abstracts from the existence of curb markets which often develop when interest rates are controlled.

(2) $p_t = s_t + p_t^* + \varepsilon_t$

(3) $m_t^d = p_t + y_t^s + \eta_1 (r_{m,t} - Ep_{t+1} + p_t) + v_t$

(4) $b_t^s = \psi(j+h_t) + (1-\psi) f_t$

$\left[\text{where } j = \ln\left(\frac{1-K}{K}\right)\right]$

(5) $m_t^s = h_t - k$

(6) $h_t = \bar{h} - \phi s_t$

(7) $r_{b,t} = (1+\theta) \left[r_{f,t} + Es_{t+1} - s_t\right]$

(8) $r_{f,t} = i_t^* + \rho_t + g_t$

(9a) $\rho_t = \gamma_0 + \gamma_1 r_{b,t} - \gamma_2 (r_{m,t} - Ep_{t+1} + p_t) + \gamma_3 (b_t^s - p_t)$

(under credit rationing)

(9b) $\rho_t = \gamma_4 + \gamma_5 r_{b,t} - \gamma_6 (r_{m,t} - Ep_{t+1} + p_t)$

(under no-credit rationing)

(10) $r_{m,t} = r_{b,t} - \omega + \chi_t$

(under full liberalization)

where: $\mu_1, \mu_2, \mu_3 \mu_4, \eta_1, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6 > 0$, $0 \leq \psi \leq 1$,

and $0 \leq | \phi | \leq \infty$.

and: 1/

y_t = level of output in period t

p_t = price level in period t

$Ep_{t+1} - p_t$ = expected inflation rate

p_t^* = foreign price level in period t

h_t = monetary base in period t

m_t = stock of money in period t

b_t^s = supply of domestic credit in period t

f_t = foreign credit to domestic banks measured in domestic currency

s_t = exchange rate measured as the domestic price of a unit of foreign currency

$Es_{t+1} - s_t$ = expected future change in the exchange rate

$r_{b,t}$ = domestic loan rate in period t

$r_{m,t}$ = domestic deposit rate in period t

$r_{f,t}$ = foreign interest rate charged to domestic banks in period t

r_t^* = foreign risk-free rate in period t

ρ_t = risk premium charged by foreign lenders to domestic banks in period t

K = required reserve ratio

n_t, ε_t, v_t, g_t, and χ_t = random shocks.

E is the expectations operator. When placed in front of a variable it represents the expected value of such variable conditioned on information available up to period t. Expectations are fully rational in the sense that the expected exchange rate and price level are consistent with the model's structural relationships.

Equations (1a) and (1b) represent semi-reduced form supply function for domestic output when firms either are or are not credit rationed. The

---

1/ All lower case letter, except those for interest rates, represent the log of the variable.

derivation of these relationships, which reflect both production functions and the conditions for labor market equilibrium is presented in Appendix I. 1/ When firms are credit rationed, the supply of domestic output (y_t^s) would be a positive function of the stock of real credit (b_t^s - p_t). This reflects the fact that since firms must make wage payments in advance of their sales of output, credit rationing limits the amount of labor they can employ. In this situation, the firms' demand for labor would be determined by the amount of real credit available and the real wage rate they must pay. In addition, output would depend positively on real production shocks (n_t) and the expected real return on deposits ($r_{m,t} - Ep_{t+1} + p_t$). Since the households' supply of labor is assumed to be a positive function of the real wage and the expected real return on deposits, 2/ a higher expected real return on deposits would increase the supply of labor and thereby the supply of output.

Equation (1b) represents the supply of output when domestic firms are not credit rationed. In this case, firms can achieve their desired levels of borrowing and output at the prevailing set of prices, the wage rate, and interest rates (see Appendix I). Although the real stock of credit would no longer impose an exogenous constraint on their activities, the level of the nominal loan rate would affect the amount of borrowing the

---

1/ As noted earlier, firms may potentially face either disequilibrium or equilibrium credit rationing. In an economy closed to external financial transactions and where interest rate ceilings are set far below market clearing levels, banks may not be able to attract the level of deposits that would allow them to create a stock of credit that equals the firms' desired amount of credit at the ceiling loan rate. Such disequilibrium credit rationing would restrain domestic output by limiting the amount of labor that firms could hire. Alternatively, even if domestic banks have access to international financial markets, equilibrium credit rationing of firms could occur if the profit maximizing decisions of international lenders led them to credit ration domestic banks. Domestic banks would then in turn be forced to credit ration domestic firms.

2/ This is based on the "normal assumption" that the substitution effect of a higher expected real deposit rate on the households' supply of labor services outweighs the income effect. See Isard, Mathieson, and Rojas-Suarez (1989) for a derivation of this labor supply function. When capital controls are totally removed, the households can hold foreign assets and the covered foreign interest rate would also affect labor supply decisions. However, since we have assumed that demand deposits and foreign assets are regarded as perfect substitutes in the households portfolio, the expected real return on deposits would be equal to the expected real return on foreign assets. Thus the expected real return on deposits would serve as a proxy for the real return on both assets.

firms would undertake to satisfy their need for working capital. 1/ As a result, the firms' demand for labor and for working capital loans would be a negative function of the real wage rate and the loan rate. In this situation, the conditions for labor market equilibrium imply that the supply of output would depend negatively on the loan rate. Moreover, just as in the credit rationing case, the supply of output would also depend positively on real production shocks and the expected real return on deposits.

Equation (2) assumes that purchasing power parity holds apart from a white noise shock. Thus, changes in the domestic price level (p_t) are determined by movements in the exchange rate (s_t), the international price of goods (p_t^*) and a random shock (ε_t). 2/ The demand for money, represented by equation (3) is taken to be a positive function of the level of nominal income ($p_t + y_t^s$) and the expected real return on money ($r_{m,t} - Ep_{t+1} + p_t$) and is affected by a random shock (v_t). 3/

To simplify our analysis, we will assume that there is a direct relationship between the stock of base money (h_t), the money supply (m_t), and the stock of domestic credit (b_t^s). In particular, banks are to be subject to a required reserve ratio of K percent on domestic deposits. 4/ Since the authorities do not pay interest on required reserves and banks are taken as maximizing expected profits, they do not hold any excess reserves. 5/ Moreover, since households are assumed to hold all of their money in the form of interest earning deposits rather than currency, the entire monetary base is held as reserves by commercial banks. In this

---

1/ The nominal, rather than real, interest rate influences the desired level of borrowing because it is assumed that those working capital loans must be repaid withing the period. Firms thus borrow from banks to meet wage payments at the beginning of the period (when labor and financial markets are open) and then repays this borrowing at the end of the period after they sell their goods. While the level of borrowing would naturally be affected by the price level expected to prevail at the end of the period, it would not be affected by the change in the price level between this period and the next.

2/ This shock has an expected value of zero and a variance of σ_ε^2.

3/ This shock has an expected value of zero and a variance of σ_v^2.

4/ This reserve ratio is not applied to any foreign borrowing by banks.

5/ If the banks were risk adverse rather than risk neutral as assumed in our analysis, they might hold excess reserves. However, with risk neutrality, banks would only be concerned with expected profits that would be maximized by holding no excess reserves.

situation, the supply of credit is given by equation (4), 1/ and the stock of domestic money is given by equation (5) (in log form).

Exchange rate policy is represented by the reaction function in equation (6) which relates the stock of base money to an exogenous component and to movements in the exchange rate. The parameter ϕ would take on the value zero with a flexible exchange rate and (in an absolute value sense) would be infinite with a fixed exchange rate.

Equations (7)-(10) describe the economy's interest rate structure. Three alternative structures are examined. For the economy that is closed to external financial transactions and whose financial system is heavily regulated, the domestic loan ($r_{b,t}$) and deposit ($r_{m,t}$) interest rates would be constrained by ceilings established by the authorities (denoted by a bar over the interest rate). For the partially liberalized and opened economy, it is still assumed that the domestic deposit interest rate is constrained by an interest rate ceiling. However, the domestic loan rate would be linked to the international loan rate that international lenders charge domestic banks. Equation (7) states that deviations of the domestic loan interest rate from interest rate parity are solely accounted for by the remaining capital control (θ) which is assumed to take the form of a proportional tax on borrowing from abroad. As represented by equation (8), the interest rate charged domestic banks by international borrowers ($r_{f,t}$) would reflect the risk-free international interest rate (i_t^*), any random component of the risk free rate (g_t), 2/ and the risk premium (ρ_t) that foreign lenders would attach to reflect the probability that the domestic banks would default on their obligations.

As was argued earlier, the probability that the domestic banks would default on their obligations reflects the probability that the domestic firms would be unable to service their debts. In this situation, it is shown in Appendix II that the determinants of the risk premium that would reflect the probability of default would differ depending on whether or not international lenders credit ration domestic banks. When there is

---

1/ The balance sheet of the commercial banks imply: $B_t^s = (1-K)M_t + F_t$ where M_t = stock of domestic deposits, B_t^s = stock of domestic credit, F_t = foreign borrowing by domestic banks expressed in domestic currency. Equation (4) is obtained by taking logs of both sides of the above expression and taking a Taylor series expansion of the right hand side. ψ represents the proportion of domestic credit accounted for by $(1-K)M_t$. The value of F_t would depend on whether or not domestic banks are credit rationed by international lenders. When there is credit rationing, F_t would be fixed by the lending decisions of international lenders. When there is no credit rationing, F_t would adjust to the value that would set B_t^s equal to the demand for loans (B_t^d) on the part of domestic firms (i.e., $F_t = B_t^d - (1-K)M_t$).

2/ The expected value of this random component is taken as zero and its variance is given by σ_g^2.

credit rationing, this risk premium would be positively related to both the level of the domestic loan rate and the real stock of credit and negatively related to the expected real return on deposits (equation (9a)). The positive effects of the loan rate and the real stock of credit arise because higher values of these variables increase the scale of the domestic firms' debt-service obligations and thereby increase the probability that an adverse shock to production would leave firms unable to service those debt obligations. In contrast, a higher expected real deposit rate would, in a general equilibrium context, increase the supply of labor 1/ and reduce the real wage confronting firms, thereby allowing them better to service their debts. When there is no credit rationing, firms can achieve their desired level of borrowing, which will be a function of the level of the loan rate and the real wage (Appendix I). In this situation, equation (9b) indicates that the risk premium would be a positive function of the loan rate (since the firm's debt-service obligations would be higher) and a negative function of the expected real return on deposit (since this would increase the supply of labor and reduce the real wage facing the firm).

Finally, in the case of a completely open and liberalized economy, all capital controls are removed, and depositors would be free to substitute between holding domestic deposits and foreign assets. If households are risk neutral, they would adjust their holdings of these assets until the expected risk-adjusted yield on each instrument was identical. Just as foreign lenders, domestic depositors would want to earn a return on domestic deposits that would compensate for the risk that domestic banks would default on their obligations to foreign creditors and domestic depositors. 2/ To simplify, we will assume that depositors' evaluation of the banks' default risk is the same as that of the foreign creditors. As indicated in equation (10), this implies that the domestic deposit rate ($r_{m,t}$) would equal the nominal loan rate ($r_{b,t}$) less real intermediation costs (ω). In addition, the deposit rate is assumed to be affected by a random shock (χ_t). 3/

To close the model, it is assumed that the output and money markets clear and that expectations are formed rationally in the sense that

---

1/ Based on the "normal assumption" mentioned in the discussion of equations (1a) and (1b).

2/ We are abstracting from the presence of deposit insurance guarantees.

3/ Since the country faces given world prices of traded goods (apart from a random shock element), domestic aggregate demand (not specified) and the supply of domestic output (equations (1a) and (1b)) would combine to determine the level of the trade balance. In addition, the exogenous variables in our model are taken as constants (apart from any random shock elements) over time.

economic agents use all the relevant and available information in forming their forecasts of the future price and exchange rate levels. 1/

IV. Exchange Rate Policy under Alternative Financial Structures

Our model can be used to consider the type of exchange rate policy (as characterized by the value of ϕ) that will best stabilize output or the domestic price level under alternative financial structures when the economy is confronted with shocks affecting foreign prices (ε_t), the supply of domestic output (n_t), the domestic demand for money (v_t), the international loan rate (g_t), and the deposit rate (χ_t). 2/ Output instability is measured in terms of the variance of output around the expected steady state level of output ($E(y_t^s - E(y_t^s))^2$). In this case, the *authorities' policy problem can be represented as:*

$$(11)\quad Z_{1,t} = \min_{\{\phi_y\}} E(y_t^s - E(y_t^s))^2$$

Since the expected values of all shocks in the model are zero, $E(y_t^s)$ would be the solution for y_t^s when all of the error terms are dropped from the equation system.

Alternatively, the authorities might desire to stabilize the price level. Price instability is calculated similarly as the variance of the price level around its expected steady state level ($E(p_t - E(p_t))^2$). In this case, the authorities policy problem becomes:

$$(12)\quad Z_{2,t} = \min_{\{\phi_p\}} E\,(p_t - E(p_t))^2$$

1/ The simple stochastic process specified for the shocks (i.e., all are distributed normally with zero mean and constant variance) and for the exogenous variables (i.e., their expected value is assumed to be constant) greatly simplified the analysis. A more complete and realistic dynamic system could be obtained if we had allowed at least part of the shocks to have permanent effects. Such an extension of our work, however, remains as future research.

2/ Earlier analyses of the specification of optimal exchange rate management in the presence of economic distrubances can be found in Benavie (1983), Bhandari (1985a), (1985b), (1985c), Daniel (1985), Driskill and McCafferty (1985), Eaton (1985), Flood and Hodrick (1985), Harkness (1985), Helpman and Razin (1987), and Turnovsky (1985).

While the authorities would presumably be interested in both output and price stability (with various degrees of importance attached to each objective), we will separately examine--as two polar cases--the ϕs that will yield either the greatest output stability or the greatest price stability. This will allow us to identify how exchange rate policies heavily weighted in favor of one or the other of the objectives would differ and possibly conflict.

As indicated in Table 1 (and in Appendices III to VI), the optimal degree of exchange market intervention (as given by the scales and signs of the ϕs) for either of the two polar objective functions depends on both the nature of the economy's financial structure and the terms and conditions under which domestic borrowers can access international financial markets. In addition, these factors determine the types of shocks to which the ϕs are sensitive. However, given the nature of the authorities' price or output stability objective, the response of the ϕs to increase in the variances of the various shocks (i.e., the signs of the partial derivatives of the ϕ with respect to the shock variance) tends to be similar across financial structures.

1. A fully regulated financial system

An economy with a fully regulated financial system is assumed to be closed to external financial transactions and to have domestic interest rates subject to binding ceilings (i.e., $r_{m,t} = \bar{r}_m$ and $r_{b,t} = \bar{r}_b$). In this case, equations (1a) and (2)-(6), as well as the assumption of output and money market equilibrium, characterize the economy's structure. 1/ As a result, the optimal value of the exchange rate intervention parameters that would best stabilize either output or the price level, are affected by shocks to foreign prices, real output, and domestic money demand but are unaffected by the behavior of international interest rates. The irrelevance of foreign interest rate shocks in this case reflects the assumption that domestic residents are totally cut off from international financial markets by capital controls.

a. Output stability

As shown in Appendix III, the value of the exchange market intervention parameter (ϕ_y) that minimizes output instability may be either positive or negative depending on whether the supply of output is more responsive to changes in either the real supply of credit or the real return on time deposits (see equation (1a)). 2/ The reasons for this ambiguity can be illustrated by considering the economy's response to an unexpected shock that increases the demand for money. This excess demand

---

1/ In this case $\psi = 1$ since no foreign borrowing is allowed. As a result, the changes in the domestic supply of credit reflect changes in the monetary base.

2/ The derivation of the supply of output when all borrowers are credit rationed is discussed in Appendix I.

Table 1. Optimal Exchange Market Intervention

	ϕ_y	$\frac{\partial \phi_y}{\partial \sigma_\varepsilon^2}$	$\frac{\partial \phi_y}{\partial \sigma_v^2}$	$\frac{\partial \phi_y}{\partial \sigma_n^2}$	$\frac{\partial \phi_y}{\partial \sigma_g^2}$	$\frac{\partial \phi_y}{\partial \sigma_\chi^2}$
I. Fully controlled economy 1/	>0 if $\mu_2 > \mu_1$	<0	>0	<0	--	--
II. Partially liberalized economy that is						
1. Credit rationed 1/	>0 if $\mu_2 > \mu_1$	<0	>0	<0	--	--
2. Not credit rationed 2/	$\gtrless 0$	$\lessgtr 0$	>0	<0	<0	--
III. Fully liberalized economy that is						
1. Credit rationed 3/	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$
2. Not credit rationed 4/	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$	$\gtrless 0$

	ϕ_p	$\frac{\partial \phi_p}{\partial \sigma_\varepsilon^2}$	$\frac{\partial \phi_p}{\partial \sigma_v^2}$	$\frac{\partial \phi_p}{\partial \sigma_n^2}$	$\frac{\partial \phi_p}{\partial \sigma_g^2}$	$\frac{\partial \phi_p}{\partial \sigma_\chi^2}$
I. Fully controlled economy 1/	>0	<0	>0	>0	--	--
II. Partially liberalized economy that is						
1. Credit rationed 1/	>0	<0	>0	>0	--	--
2. Not credit rationed 2/	$\gtrless 0$	<0	>0	>0	>0	--
III. Fully liberalized economy that is						
1. Credit rationed 3/	$\gtrless 0$	<0	>0	>0	>0	>0
2. Not credit rationed 4/	$\lessgtr 0$	<0	>0	>0	>0	>0

1/ See Appendix III.
2/ See Appendix IV.
3/ See Appendix V.
4/ See Appendix VI.

for money would lead the exchange rate to appreciate and the price level to fall. As the domestic price level declines, the real supply of credit would rise (thereby stimulating output). However, since the domestic price level would have fallen below its long-term expected level, this would create the expectation of a future rise in prices, and this would lower the expected real return on deposits 1/ (thereby reducing output). If the supply of real credit effect dominates ($\mu_1 > \mu_2$), for example, then a positive money demand shock, which would lower the domestic price level, would also raise output. In contrast, if $\mu_1 < \mu_2$, a positive money demand shock would lower both the price level and output. When the authorities want to stabilize domestic output, it is therefore not surprising that their exchange rate policy would have to differ depending on whether a money demand shock or a foreign price shock raised or lowered income. To avoid a long taxonomy of cases in what follows, we will focus on the formulation of exchange rate policy when $\mu_2 > \mu_1$.

If the authorities are primarily interested in stabilizing output, then ϕ_y would generally be positive when $\mu_2 > \mu_1$ (Table 1). 2/ In this case, any shock that produces an exchange rate appreciation would then lead the authorities to increase the stock of base money (see equation (6)). It has already been noted that, when $\mu_2 > \mu_1$, any decline in the price level (which would be associated with an exchange rate appreciation) would lead to a fall in output. If the authorities therefore increase the stock of base money as the exchange rate appreciates, this would increase the supply of real money and credit thereby stimulating output, which would help offset the initial decline in output.

As indicated in Table 1, any increases in the variances of the underlying shocks would naturally influence the scale of optimal exchange market intervention. For example, an increase in the variance of foreign price shocks (a higher σ_ε^2) would lower the optimal ϕ_y (i.e., a move toward greater exchange rate flexibility). This result reflects the fact that a positive foreign price shock would initially raise the price level and increase both the expected real return on deposits and output. 3/ Since the higher price level would reduce the real money supply, the

---

1/ Since all shocks in our model have an expected value of zero, the expected future price level (Ep_{t+1}) is determined by only the non-stochastic elements in our model and would therefore be unaffected by any temporary money demand shock. As a result, the real return on deposit ($\bar{r}_m - E_{t+1} + p_t$) fall as p_t declines since it would be expected that the price level would eventually rise to its long-run value.

2/ As shown in Appendix III, ϕ_y will be more likely to be positive as the variance of money demand shock rises relative to the variance of real output shocks.

3/ The increase in the expected real returns on deposits occurs as the price level rises relative to the expected steady-state price level (which is unaffected by transitory shocks). This would raise output (see equation 1b).

resulting excess demand for money would lead to an appreciation of the exchange rate. As the exchange rate appreciates, the initial rise in the price level (due to the positive foreign price shock) would be partially offset. As a result, the expected return on deposits and output would fall. The magnitude of these offsetting effects rises as the degree of exchange rate flexibility increases. Therefore, as the variance of foreign price shocks increases, the authorities would find it optimal to rely on greater exchange rate flexibility to offset these shocks.

In contrast, an increase in the variance of money demand shocks (a higher σ_v^2) would lead to the adoption of less exchange rate flexibility (see Appendix III). This result differs from the traditional conclusion that a high variance of "monetary" shocks raises the desirability of greater flexibility of exchange rates. 1/ Our result differs from the traditional conclusion because many of the earlier analyses gave the authorities the object of stabilizing consumption and have taken output as exogenous and fixed (apart from a random component). 2/ In our analysis, however, monetary shocks directly affect output through the assumption that real credit is needed to finance the production process. In particular, output is affected by changes in the real stock of credit and the expected real deposit rate as well as by random output shocks (equations (1a) and (1b)). As a result, the exchange rate (and price level) movements that are needed to restore money market equilibrium in the face of a money demand shock could affect the real return on deposits and thereby output. In fact, the closer that ϕ_y is to zero (a flexible exchange) the greater would be the effects of a money demand shock on the expected real return on money. In this situation, the authorities could help stabilize output by undertaking greater exchange market intervention (increasing ϕ_y) as σ_v^2 rose. As a result, more of any positive money demand shock would be satisfied through increases in the money supply (and therefore increases in foreign exchange reserves) rather than declines in output or a fall in the price level.

Alternatively, if the variance of output shocks (σ_n^2) increases, then output instability would be minimized by reducing ϕ_y. A positive output shock would not only raise output but would also lead to an appreciation of the exchange rate (since it would create an excess demand for money). With $\mu_2 > \mu_1$, any exchange rate appreciation would lower output and thereby help offset the effects of the positive shock to the supply of

---

1/ See, for example, Frenkel and Aizenman (1982).

2/ When the objective is to stabilize consumption in the context of an exogenously determined output and zero capital mobility, flexible exchange rates are preferable in the presence of monetary shocks because the current account and, therefore, consumption remains unchanged. While our result would be similar to the traditional conclusion if $\mu_1 > \mu_2$ in the present case, our later analysis of a partially or fully liberalized economy that is not credit rationed will show that our nontraditional conclusion if hold even when the relative size of μ, and μ_2 are irrelevant.

output. A decline in ϕ_y would amplify the offsetting appreciation of the exchange rate and would therefore amplify the offsetting effect on output.

b. Price stability

When the authorities are principally concerned with maintaining price stability, exchange rate policy also involves interventions that would reduce (increase) base money as the exchange rate depreciates (appreciates). ϕ_p is therefore positive (see Appendix III). Such a strategy would help stabilize the price level by creating money market conditions that would lead to exchange movements that offset any initial appreciation or depreciation. For example, an initial appreciation of the exchange rate would lead the authorities to increase the monetary base. This increase in the monetary base would create an excess money supply that would produce an offsetting depreciation of the exchange rate. In the sense that both ϕ_y and ϕ_p are positive, then there is no fundamental conflict between the exchange market policies that will promote output and price level stability in the case of a fully regulated financial system.

As in the case when output stability was the objective, the authorities would find it optimal to reduce the scale of their intervention as the variance of foreign price shocks (σ_ϵ^2) increases. This allows exchange rate movements to have greater scope to offset the effect of the foreign price shock on the domestic price level (Table 1). However, as the variances of demand for money shocks (σ_v^2) or real output shocks (σ_n^2) increase, the authorities' intervention in the exchange market would become more active (ϕ_y would rise). Since a positive money demand shock (or a positive supply of output shock) would create an excess demand for money, this would lead the exchange rate to appreciate which would drive down the domestic price level. To stabilize the domestic price level, the authorities would increase base money so as offset the money demand shock (or the effect of a positive shock on that demand for money).

One conflict between an exchange rate policy designed to stabilize output and that designed to stabilize prices thus occurs in the optimal response to an increase in the variance of output shocks. When output stability is the objective, the authorities would reduce ϕ_y in order to allow exchange rate movements greater scope for offsetting the initial effects of the shock on output. However, larger exchange rate adjustments would conflict with the price stability objective.

2. A partially opened and liberalized economy

As a first step in liberalizing the country's financial structure, the authorities are assumed to allow banks to borrow abroad and to use the proceeds to fund loans to domestic borrowers. The authorities are also assumed to free the domestic loan rate from interest rate ceilings. Some capital controls continue to exist. Domestic depositors are still prohibited from moving their funds abroad, and foreign borrowing by banks is taxed (at rate θ). Moreover, the interest rate ceiling on the deposit rate is maintained.

As the authorities begin to liberalize the domestic financial system and to open the economy to external financial transactions, exchange rate policy will for the first time be affected by the perceived creditworthiness of domestic borrowers in international markets. If domestic banks are credit rationed by international lenders because of creditworthiness considerations, for example, they would be unable to obtain the amount of credit that they would find profitable (at existing international interest rates) to lend to domestic firms even when capital controls are weakened or eliminated. In this situation, the interest rates that the banks would be charged by international lenders would be below the "shadow" price that firms would attach to an additional dollar of credit 1/ and changes in international interest rates would not affect the amount of external borrowing undertaken by domestic borrowers. 2/ In contrast, if domestic borrowers are not credit rationed, 3/ then changes in international interest rates would affect domestic borrowers' use of international markets.

In order to analyze how the authorities' exchange rate arrangements are affected by the creditworthiness considerations, we first consider the case when domestic banks are credit rationed by international lenders and then the case when they are not.

1/ As discussed earlier, such credit rationing would arise if international lenders took the view that the expected profit of an additional dollar of lending was zero or negative because such lending would increase the probability of default sufficiently to more than offset the higher interest income associated with the new loan. Since even with credit rationing some foreign credit could be made available to domestic borrowers, the total amount of credit available to borrowers in a partially open and liberalized economy would typically be larger than that in the closed economy considered in the previous section.

2/ This would be strictly true only as long as any increase in international interest rates does not lower the domestic borrowers' desired level of borrowing below the amount of credit made available by international lenders.

3/ Even when domestic borrowers are not subject to equilibrium credit rationing, the interest rate paid on external borrowing would still be affected by creditworthiness considerations (equation (8)). As a result, the interest rate premium (relative to the risk free international interest rate) that domestic borrowers would have to pay would rise as their level of borrowing increased relative to their steady state level of borrowing.

a. A partially liberalized economy facing equilibrium credit rationing

If domestic banks face credit rationing by international lenders, then the type of exchange rate policies that would best stabilize output or prices would not differ from those used in the fully regulated economy considered in the previous section. In terms of our model, this situation arises because, when international lenders credit ration domestic banks (and thereby domestic firms), equations (1a) and (2)-(6) fully characterize the determinants of domestic output and prices. As already discussed, the loan rate does not represent the marginal cost of funds with credit rationing and therefore does not enter into the determination of output and prices. 1/ Hence, the scale of intervention would not be affected by the variability of international interest rates (σ_g^2) or the degree to which the authorities weaken their remaining capital controls on external borrowing (as given by θ).

If international interest rate shocks do not alter private behavior because of credit rationing, exchange rate policy can be focused on mitigating the effects of shocks to foreign prices, the demand for money, and the supply of output. The similarities in the terms and conditions under which domestic borrowers can obtain additional credit in a fully regulated financial system and in a partially opened system when there is credit rationing by international lenders leads to similar exchange market intervention strategies (Table 1). Since the rationale for these intervention strategies was discussed in the previous section, we will instead turn to the case when capital controls are relaxed and domestic borrowers are not credit rationed.

1/ This reflects the fact that, at the margin, changes in international interest rates would affect domestic borrowers' excess demand for credit but would not alter the amount of external credit made available (which is constrained by credit rationing). As noted earlier, this assumes that the foreign interest rate does not reach a level where it drives the excess demand for credit to zero. It should be noted that the "equilibrium" credit rationing confronting domestic borrowers in this case differs from that evident in the closed financial system considered in the previous section. In the case of the closed economy, "disequilibrium" credit rationing arose because the authorities set ceilings that kept interest rates below their market clearing levels. It would be possible in an economy with effective capital controls but a liberalized domestic financial system (i.e., where interest rate ceilings were removed), that domestic borrowers might or might not be credit rationed by domestic banks. See Isard, Mathieson, and Rojas-Suarez (1989) for an analysis of this situation. In the current case, however, credit rationing, if it exists, is an "equilibrium" phenomena reflecting the desire of lenders not to become overexposed to a particular borrower (i.e., not to lend beyond the point where the expected profit on the last dollar of lending is zero).

b. A partial liberalized economy not facing equilibrium credit rationing

When domestic borrowers are not credit rationed by international lenders, the economy's structure is represented by equations (1b), (2), (3), (5)-(8), and (9b). In this case, international interest rate variability affects domestic borrowing, spending and employment decisions (Appendix IV). As a result, the authorities' exchange rate arrangements would generally be designed to mitigate the effects of interest rate shocks, as well as shocks to foreign prices, output, and the demand for money.

(1) Output stability

If the authorities' objective is to stabilize output, the optimal intervention parameter (ϕ_y) would take on a positive value when the variance of monetary shocks (defined to include foreign price shocks) dominates the variances of shocks to foreign interest rates and output. This exchange rate policy arises because a positive shock to either the foreign loan rate or the demand for money leads to a decline in output that could be offset by exchange market intervention that increases the monetary base. For example, consider an unanticipated monetary shock which increases the demand for money. This excess demand for money would in turn lead to an appreciation of the exchange rate (and, as a result, a fall in output) 1/ in order to restore money market equilibrium. If ϕ_y is positive, the monetary base would increase as the exchange rate appreciates, and this would help restore money market equilibrium without as large an appreciation of the exchange rate (or fall in income.)

The value of the optimal intervention parameter naturally changes as the variance of the various monetary, interest rate, and real shocks increase. When the variance of money demand shocks increases, for example, the value of the exchange rate intervention parameter would increase implying greater exchange rate fixity. 2/ This occurs because, just as in the fully regulated economy, the dependence of output on the

---

1/ The appreciation would work to increase the loan rate and reduce the return to deposits which would generate a lower level of output (equation (1b)). As the exchange rate appreciated, its value would decline relative to its expected steady state level (Es_{t+1}), which would create the expectation of a future exchange rate depreciation. This would raise the domestic loan rate relative to the international loan rate (equation (8)). In addition, the domestic price level would also decline (due to the exchange rate appreciation) relative to its expected steady state level (Ep_{t+1}) thereby creating the expectation of a future increase in prices. Such an expectation would reduce the expected return on deposits as long as $\bar{r}_m$ remained constant.

2/ In the case when $\phi_y > 0$, an increase in the variance of foreign price shocks would lead to a lower value of ϕ_y. This result is similar to that obtained in the fully controlled economy.

financial constraint as well as the presence of capital market imperfections imply that monetary shocks have real effects even under flexible exchange rates. In particular, since the nominal deposit rate is still subject to an official ceiling, a positive shock to the demand for money would result in a decline in both the real deposit rate and output as the exchange rate appreciated. 1/ Moreover, the exchange rate appreciation would lead to an increase in the loan rate (see equation (7)) which would induce a further decline in output. If the exchange rate was instead to remain fixed (i.e., $\phi_y = \infty$), then domestic prices and the loan interest rate would remain constant, implying no change in output. 2/ The only impact of this shock would be an increase in foreign reserves. As a result, in order to stabilize output, exchange market intervention would increase as the relative variance of monetary shocks increases. This result again differs from the traditional conclusion that flexible exchange rates are optimal if monetary shocks dominate the system in part because our objective is output rather than consumption stability.

Since the exchange rate flexibility lowers the impact of real shocks on output, an increase in the variance of output shocks (σ_n^2) would lead the authorities to reduce the scale of their exchange market intervention. 3/ Once again, this result contrasts with the traditional conclusion that a fixed rate would be best at stabilizing consumption in the face of greater variability of real shocks. This again reflects our output stability objective as well as our model's linkages between output and the money market. In particular, a positive output shock would raise the demand for money and lead to an exchange rate appreciation and thereby a lower price level. Since the expected steady state price level is not affected by transitory shocks, the decline in price level would create the expectation of a future rise in prices (to the expected steady state level). Such expected inflation would reduce the real deposit rate (since the nominal deposit rate is fixed) and thereby decrease output (equation (1b)). The decline in output would also be exacerbated by the negative effect of the rise in the loan rate induced by the initial

---

1/ A positive money demand shock would generate an exchange rate appreciation which would lower the domestic price level. As noted earlier, the expected steady state price level (Ep_{t+1}) would be unchanged by this transitory shock (since all shocks have an expected value of zero), and the lower initial price level would give rise to the expectation of a rise in the price level over time. Such inflation would reduce the real yield on deposits since $\bar{r}_m$ is fixed.

2/ From Appendix IV, it is clear that when $\phi_y = \infty$, then

$$\frac{\partial p_t}{\partial v_t} = \frac{\partial r_{b,t}}{\partial v_t} = \frac{\partial y_t}{\partial v_t} = 0.$$

3/ As shown in Appendix IV, this is strictly true as long as the effect of the variance of interest rate shocks is small relative to the combined effects of the other variances.

exchange rate appreciation. 1/ This decline in output would at least partially offset the initial direct effects of the positive output shock. If the exchange rate was instead fixed, the price level and the loan rate would remain unaffected by the output shock and no offsetting output adjustment would occur.

Finally, an increase in the variability of the foreign interest rate would lead the authorities to reduce their intervention in the exchange rate market. A positive shock to foreign interest rates would raise the domestic loan rate and, therefore, would have a negative effect on output (equation (1b)). The decline in output would create an excess supply of money by reducing the demand for money, which would put pressure on the exchange rate to depreciate. However, since the expected steady state exchange rate is not affected by transitory shocks, this depreciation would push the exchange rate above its expected state value thereby creating the expectation of a future appreciation. Such expectations would lower the domestic loan rate (equation (7)) thereby helping to offset the initial foreign interest rate shock. More exchange rate flexibility therefore helps to insulate output from foreign interest rate shocks.

(2) Price stability

For a partially liberalized economy whose borrowers are not subject to credit rationing, the optimal intervention parameter (ϕ_p) is positive (negative) as the combined variances of the domestic monetary and real shocks (σ_m^2 and σ_n^2) are larger (smaller) than those for foreign price and interest rate shocks. For example, it has already been noted that a positive domestic shock (v_t or n_t) results in an appreciation of the exchange rate and in a reduction in the domestic price level. If ϕ_p is positive, then the monetary base would increase as the exchange rate appreciates (see equation (6)). Such monetary expansion would tend to generate an exchange rate depreciation that would offset (at least partially) the initial decline in the price level.

The effect of higher variances of the various shocks on ϕ_p are similar to those obtained in the case of a fully controlled economy. Namely, if the variance of the domestic monetary shocks (σ_v^2) and real output shocks (σ_n^2) rise, the authorities would find it optimal to increase the value of ϕ_p (Table 1). This reflects the fact that, if increased price variability arises from domestic sources, it would be optimal to move toward a fixed exchange rate and allow the money supply to adjust readily to change in the demand for money associated with either money demand or output shocks. This would tie the price level to

---

1/ As the exchange rate appreciates, its value would decline relative to the expected steady state level of the exchange rate (Es_{t+1}) which is unaffected by transitory shocks. This expected future depreciation would widen the wedge between the domestic loan rate and the risk-free international interest rate (equation (8)).

developments in the (relatively) more stable international economy. If instead, the variance of foreign price shocks (σ_{ε}^{e}) rises relative to the variance of domestic shocks, it would be optimal to increase the insulation of domestic variables from those foreign shocks, and this can be achieved by increasing the flexibility of the exchange rate; namely by lowering the optimal value of the foreign exchange intervention parameter. 1/ In contrast, a higher variance of foreign interest rate shocks would lead the authorities to raise ϕ_p. A foreign interest rate shock would raise the domestic loan rate and depress output. This decline in output would in turn reduce the demand for money and put pressure on the exchange rate to appreciate (which would lower the price level). To avoid this price change, the authorities would focus on stabilizing the exchange rate.

In summary, a partial liberalization of capital controls and domestic interest rate ceilings may lead to either relative little or substantial changes in exchange rate policy. The key factor determining what policy changes are required would be the nature of the terms and conditions under which domestic residents can access international financial markets. If international lenders effectively credit ration domestic borrowers (leaving them with an excess demand for credit), the type of exchange rate policy that best stabilizes either domestic output or the price level would not be very different from that in an economy with a closed financial system. However, if domestic borrowers are not credit rationed, they will be able to obtain their desired level of international credit (while paying a higher interest rate as they increase the scale of their borrowing to reflect increased default risk). In this situation, the formulation of exchange rate policy would be affected by changes in the variability of international interest rate shocks as well as the nature of the remaining capital controls and restrictions on the domestic financial system.

3. A fully liberalized and open economy

The formulation of exchange rate policy in an economy in which all capital controls and domestic interest rate ceilings have been removed needs to take into account not only the terms and conditions under which domestic borrowers can access international markets but also the fact that domestic depositors are free to shift between holding domestic deposits and external assets. In terms of our model, the deposit rate (r_m) is now endogenous (equation (10)). Moreover, in a competitive financial system, the deposit rate would differ from the loan rate only as a result of real intermediation costs (the ω in equation (10)) 2/ and a random shock. In

---

1/ When $\phi_p = 0$ (i.e., fully flexible exchange rates),

$\frac{\partial s_t}{\partial \varepsilon_t} = -1$ and $\frac{\partial p_t}{\partial \varepsilon_t} = 0$ (see Appendix IV). The response of the loan rate to these foreign shocks is also minimized when $\phi_p = 0$.

2/ ω would also reflect the required reserve ratio.

addition, it is assumed that the tax on foreign borrowing (θ) is set equal to zero. While the removal of capital controls would eliminate official restrictions on access to international financial markets, the formulation of exchange rate policy would still be affected by whether domestic borrowers do or do not face credit rationing by international lenders.

a. <u>A fully liberalized economy facing credit rationing</u>

When domestic banks are credit rationed by international lenders, the economy's structure is represented by equations (1a), (2)-(8), (9a), and (10). In this situation, the specification of the intervention parameter that would best stabilize domestic output becomes quite complex (Appendix V). In part, this reflects the fact that the authorities must now respond to a broad set of international price and interest rate shocks. Moreover, similar (e.g., positive) shocks to the international loan and deposit rates would have conflicting effects on the exchange rate and domestic output. As a result, knowledge of the relative sizes of the variances of the various shocks is needed to specify the optimal value of ϕ_y. Therefore, in what follows we will concentrate on identifying the optimal value of ϕ_p that would best stabilize prices.

If the variance of foreign price shocks is small relative to the combined variances of the other shocks, then $\phi_p > 0$. 1/ This result reflects the fact that a positive shock to either money demand, output, the loan rate, or the deposit rate would generate a potential excess demand for money and an appreciation of the exchange rate (and a decline in the price level). $\phi_p > 0$ implies that the authorities would respond to the exchange rate appreciation by increasing the monetary base, and this would lead to at least a partially offsetting depreciation of the exchange rate (and thereby the initial decline in the price level).

When ϕ_p is positive, 2/ the effects of increases in σ_ξ^2, σ_γ^2, and σ_n^2 on the optimal value of ϕ_p are identical (in sign) to those in the case of a partial liberalized economy facing credit rationing. In addition, the authorities would find it optimal to increase ϕ_p when either the variance of the loan rate shocks (σ_g^2) or the variance of the deposit rate shocks (σ_χ^2)) increases. Notice that, in the case of a partially liberalized

---

1/ When the variance of foreign price shocks is relatively large, the sign of the optimal value of ϕ_p is unclear. On the one hand, a positive shock to foreign prices increases the domestic price level generating a potential excess demand for money that tends to appreciate the exchange rate. On the other hand, however, the resulting increase in prices might lower the supply of output if the coefficient representing the effect of the real stock of credit on output (μ_1) outweighs the coefficient representing the effect of the real interest rate on output. In that case, there would be a potentially offsetting decline in the demand for money which would tend to depreciate the exchange rate.

2/ As shown in Appendix V, the conditions for $\phi_p > 0$ also imply $\partial s_t/\partial \varepsilon_t < 0$.

economy facing credit rationing, interest rate shocks did not influence ϕ_p since the deposit rate was fixed by interest rate ceilings and the foreign loan rate did not represent the true shadow price of an additional dollar of credit. While it is still true that the loan rate does not represent the shadow price of credit (since there is credit rationing) in the present case, positive loan rate and deposit rate shocks would raise the domestic deposit rate which would generate an excess demand for money and an appreciation of the exchange rate. To prevent or offset this exchange rate appreciation, the authorities would increase the stock of base money as the exchange rate appreciates. Moreover, as the variance of these interest rate shocks increases, so would the optimal degree of exchange market intervention.

These considerations imply that, apart from the authorities' response *to interest rate shocks, there is a strong similarity between optimal* exchange rate arrangements that best stabilize the price level in a partially and fully liberalized economy. In part, this similarity reflects the fact that credit rationing acts as a remaining market "imperfection" in the system even when all capital controls and domestic restrictions are removed.

b. Fully liberalized economy whose borrowers are <u>not credit rationed by international lenders</u>

When domestic borrowers are not credit rationed by international lenders, the economy is represented by equations (1b), (2), (3), (5)-(8), (9b), and (10). Although all financial controls have been relaxed and there is no credit rationing, real and financial shocks still affect the behavior of output and the price level (see Appendix VI). This reflects our initial assumption that firms need to finance their wage bill by borrowing in advance from commercial banks and that loans are repaid during the current period. This "financial constraint" implies that (as indicated in equation (1b)) the supply of output depends on the <u>nominal</u> loan rate. 1/ As a result, there is a linkage between the real and the financial sectors that does not disappear even with the removal of capital controls and interest rate ceilings. To further clarify the role of financial constraint, consider a "classical" economy where all transactions take place simultaneously and the real sector is insulated from the behavior of financial variables. In our model, such an economy could be represented by assuming $\mu_4 = \gamma_5 = 0$; that is, the supply of output only depends on the real interest rate. From Appendix VI, it is clear that in that case a monetary shock affects the nominal domestic deposit rate and the exchange rate in opposite directions but in the same magnitude and as a result leaves output unchanged <u>independently of the exchange rate regime</u>. 2/ In the case of a real shock to the supply of

---

1/ See Appendix I for the derivation of this result.

2/ From Appendix VI, when $\mu_4 = 0$, then $\frac{\partial y_t}{\partial v_t} = \mu_5 (S_2 + R_2) = 0$

output, it can also be shown that the effect on the exchange rate would offset the effect on the interest rate, and, as a result, output changes proportionally to the real shock 1/ also independently from the exchange rate regime. The irrelevance of the exchange rate regime in a world where real variables are independent of the monetary sector is a well known result (see Helpman (1981)); but it has also been shown 2/ that the choice of exchange rate regimes is a relevant issue in economies where the financial sector impinges on the behavior of the real sector.

Since the authorities must now design their exchange rate policy to deal with broad range of shocks, the specification of the optimal ϕ_y and ϕ_p is naturally quite complex. Even when the authorities are primarily concerned about price stability, the model does not yield unambiguous results unless some assumptions are made about the values of the parameters. However, when the financial constraint on firms has a determinant effect on the supply of output, 3/ we obtain results for the effects of the variance of the shocks on ϕ_p^* that are similar to those obtained in the case of partial liberalization with no credit rationing.

V. Conclusions and Unresolved Issues

Our analysis indicates that the removal of capital controls and liberalization of the economy affects exchange rate policy both by broadening the set of shocks affecting the economy and by altering the nature of the impact of a given shock on domestic output and prices. For example, shocks to international interest rates would have an increasingly important effect on the economy (and therefore the formulation of exchange rate policy) as domestic borrowers and depositors can more freely engage in external financial transactions. While the optimal scale of exchange market intervention can vary with the nature of the economy's financial structure, there is nonetheless a similarity in the response of the optimal degree of intervention to increases in the variance of the various domestic and foreign shocks across all financial structures, as long as the authorities' basic price or output stability objective remains unchanged. At the most fundamental level, these similarities reflect the influence of the financial constraint facing firms that they must finance their working capital needs prior to the sale of their output. This creates real and financial sector linkages that determine the economy's response to the various domestic and real shocks. While changes in the economy's capital controls and domestic financial regulations can amplify (or reduce) the effects of a given shock on prices or output, the presence of the financial constraint ensures that the nature of that impact (i.e., whether it is positive or negative) is stable across financial structures.

1/ From Appendix VI, when $\mu_4 = 0$, $\gamma_5 = 0$, $\frac{\partial y_t}{\partial n_t} = (1 + \mu_5(S_3+R_3)) = 1$.

2/ See, for example, Aschauer and Greenwood (1983).

3/ That is when $\mu_4 > \mu_5 + \eta_1$ and that $\gamma_5 > \gamma_6$ (see Appendix VI).

In addition, our analysis indicates that the combination of domestic financial liberalization and the removal of capital controls would not in general create a preference for one particular type of exchange rate arrangement. The optimal change in exchange rate arrangements would reflect both the changes in the financial structure of the economy as liberalization takes place and the relative sizes of the various shocks that impinge on the economy.

Finally, our analysis indicates that the extent of the changes in optimal exchange rate arrangements that would occur as financial liberalization takes place would be strongly influenced by the nature of the terms and conditions under which domestic borrowers can access international financial markets. These terms and conditions would reflect both the nature of the country's capital controls and the decisions of international lenders regarding the creditworthiness of domestic borrowers. As noted earlier, creditworthiness considerations influence both the interest cost of obtaining external credits and the availability of those credits if lenders become sufficiently concerned about the likelihood of default. As a liberalization proceeds, creditworthiness considerations therefore replace official restrictions as the key limitation on market access. This also implies that shifts in market perceptions of the creditworthiness of a country's borrowers could imply a sharp change in the nature of a country's optimal exchange rate arrangements, especially if this change in perceptions leads to the imposition of credit rationing.

There are a number of important issues that we have not been able to address in our analysis because of certain simplifying assumptions. Some of these issues have considerable policy relevance. For example, although we have assumed that the relationship between the stock of base money and the money supply would not be affected by the removal of capital controls or the domestic financial liberalization, this has clearly not been the case in most industrial countries. The money multiplier and the velocity of money have often been influenced by the removal of interest rate ceilings and the availability of new financial instruments. In addition, we have not allowed for the feedback effects between countries at different stages of domestic financial liberalization and employing different degrees of capital controls. Such feedback effects could be particularly important for countries on the periphery of the European Community, especially as 1992 approaches. Our analysis has also abstracted from the role of securities and equity markets. While incorporating the influence of these markets is clearly important, the requirement that firms fund their working capital needs (from whatever financial source) prior to production would ensure the existence of strong real and financial sector linkages no matter how complex the financial structure. Finally, we have ignored the effect of different types of fiscal systems on capital flows and the location of financial and real activity. Examining the effects of these factors on the relationship between financial structure and exchange rate policy leaves considerable scope for future work.

Derivation of the Aggregate Supply Function

Assume that the production sector of the economy is composed of s identical entrepreneurs who maximize the expected utility of their planned consumption over time. Assume that the entrepreneurs are risk neutral and, therefore, that their instantaneous level of utility (U_t) is linearly related to the level of their consumption. Thus,

$$(I.1) \qquad U_t = aC_t$$

with "a" representing the marginal utility of consumption.

Each entrepreneur owns a firm and produces a single homogeneous good (Y) using capital (K) and labor (L). It is assumed that the output produced by each firm is subject to a random shock (N). While all entrepreneurs are assumed to share and to know the distribution of the shocks, they do not know the actual value of the shocks that will hit their output during the current and future period. Assume that each firm's output is given by the following linear homogenous production function (f):

$$(I.2) \qquad Y_t = f_t\left(K_t, L_t\right) + N_t$$

and the random shock affecting each firm is normally distributed over the range between $-\infty$ and ∞ with zero mean, constant variance, and density function $g(N_t)$.

It is assumed that entrepreneurs need to make wage payments to employees at the beginning of each period and to finance their wage bill by borrowing from the domestic sector. Those loans (B) are obtained at the borrowing rate r_b and repaid at the end of the period when the firm sells its output. Thus, the entrepreneur faces the following constraint:

$$(I.3) \qquad \frac{B_t}{P_t} = \frac{W_t}{P_t} L_t$$

where: W_t = wage rate in period t

P_t = price of the domestic good in period t.

In addition to their demand for labor and consumption plans, the entrepreneur also formulates plans for investment ($K_{t+1} - K_t$). For simplicity, it is assumed that capital does not depreciate over time and that capital can be sold at the same price as that prevailing for current output. The entrepreneur's budget constraint will be given by:

$$(I.4) \qquad C_t + K_{t+1} - K_t = Y_t - \left(1+r_{b,t}\right) \left(W_t/P_t\right) L_t$$

In formulating plans, the entrepreneur recognizes that some production shocks will leave the firm unable to service its debt obligation out of the proceeds from the sale of its output. Let N_t^* denote the scale of the shock for which the firm's entire output is just sufficient to meet its debt obligations, thus:

$$(I.5) \qquad N_t^* = \left(1+r_{b,t}\right) \left(W_t/P_t\right) L_t - f_t \left(K_t, L_t\right)$$

with $C_t = K_{t+1} = 0$ at this point.

When a shock is more negative than N_t^*, the firm is considered to be in a situation of "default" in which the entrepreneur "dies"--i.e., his current and future consumption is zero. These random shocks have important implication for the behavior of the supply of output by firms. This is so because uncertainty about production outcomes leads to risk premia on loans to firms and, in some cases to quantitative credit rationing. In what follows an entrepreneur's supply of output will be derived under two alternative assumptions: (a) at the prevailing interest rates, the firm is able to obtain its desired amount of bank loans and (b) at the prevailing interest rates, the firm is credit rationed in that its demand for real bank loans exceeds the actual supply.

1. No credit rationing

Letting V(.t) represent the entrepreneur's value function (indirect utility function), his optimization problem becomes:

$$(I.6) \qquad V\,(.t) = \max_{\{C_t,\, K_{t+1},\, L_t\}} E \left(U_t + \beta V(.t+1)\right)$$

subject to the budget constraint given in (I.4), the production function given in (I.2) and the utility function given in (I.1); and where β is the discount factor and E is the expectations operator.

The first order conditions for a maximum imply that:

$$(I.7) \qquad \frac{\partial f_t}{\partial L_t} = \left(1+r_{b,t}\right) \frac{W_t}{P_t}$$

$$(\text{I.8}) \qquad \frac{1}{\beta} = \left(1+ \frac{\partial f_{t+1}}{\partial K_{t+1}}\right) Q_{t+1}$$

where Q_t represents the firm's probability of nondefault at time t, and is given by: $\int_{N^*_t}^{\infty} g\left(N_t\right) dN_t$

$$(\text{I.9}) \qquad C_t = f_t\left(K_t,\ L_t\right) + E\left(N_t\right) - \left(1+r_{b,t}\right) \left(W_t/P_t\right) L_t - K_{t+1} + K_t$$

Equation (I.7) implies that labor is hired up to the point where its marginal product equals the expected real wage adjusted for the cost of borrowing. Equation (I.8) represents the optimal intertemporal allocation of consumption and equates the ratio of current to future discounted marginal utilities of consumption to the expected marginal return (in terms of goods) from investment. Equation (I.9) states that the entrepreneur's consumption must satisfy his budget constraint.

Total differentiation of equation (I.8) and an updated (to period t+1) version of (I.7), lead to the following two equation system

$$\begin{bmatrix} \dfrac{\partial f^2_{t+1}}{\partial K_{t+1}\partial L_{t+1}} & \dfrac{\partial f^2_{t+1}}{\partial L^2_{t+1}} \\ Q_{t+1} \dfrac{\partial^2 f_{t+1}}{\partial K^2_{t+1}} + \left(1+ \dfrac{\partial f_{t+1}}{\partial K_{t+1}}\right)^2 g(N^*_{t+1}) & Q_{t+1} \dfrac{\partial^2 f_{t+1}}{\partial K_{t+1}\ \partial L_{t+1}} \end{bmatrix} \begin{bmatrix} dK_{t+1} \\ dL_{t+1} \end{bmatrix}$$

$$= \begin{bmatrix} (1+E(r_{b,t+1}))\ dE\left(\dfrac{W_{t+1}}{P_{t+1}}\right) + E\left(\dfrac{W_{t+1}}{P_{t+1}}\right) d(1+E(r_{b,t+1})) \\ g(N^*_{t+1})\ E\left(\dfrac{W_{t+1}}{P_{t+1}}\right) L_{t+1}\ d(1+E(r_{b,t+1})) \\ + g(N^*_{t+1})(1+E(r_{b,t+1}))\ L_{t+1}\ dE\left(\dfrac{W_{t+1}}{P_{t+1}}\right) \end{bmatrix}$$

The determinant of the coefficient matrix (Δ) will equal

$$(I.10)\quad \Delta = Q_{t+1}\left[\left(\frac{\partial^2 f_{t+1}}{\partial K_{t+1}\partial L_{t+1}}\right)^2 - \frac{\partial^2 f_{t+1}}{\partial K^2_{t+1}} \cdot \frac{\partial^2 f_{t+1}}{\partial L^2_{t+1}}\right]$$

$$- \frac{\partial^2 f_{t+1}}{\partial L^2_{t+1}}\left(1+\frac{\partial f_{t+1}}{\partial K_{t+1}}\right)^2 g(N^*_{t+1})$$

In a nonstochastic environment with diminishing returns, the term in square brackets is negative. However, in a stochastic environment, the second term would be positive. Since the probability of N^*_{t+1} occurring is typically much smaller than the probability of nondefault, it is assumed that $\Delta < 0$ (which would be true in a nonstochastic environment). This will yield the firm's implicit demands for capital and labor as:

$$(I.11)\quad K_{t+1} = \xi\left[1+E(r_{b,t+1}),\ E(W_{t+1}/P_{t+1})\right]$$

$$\text{with } \partial\xi/\partial\left[1+E(r_{b,t+1})\right] < 0; \qquad \frac{\partial\xi}{\partial(W_{t+1}/P_{t+1})} < 0$$

$$(I.12)\quad L_t = l(1+r_{b,t},\ W_t/EP_t)$$

$$\text{with } \partial l/\partial(1+r_{b,t}) < 0; \qquad \frac{\partial l}{\partial(W_t/p_t)} < 0$$

Equation (I.11) indicates that, if the entrepreneur expects that the loan rate or real wage will rise in period t+1, other things equal, it will reduce its investment since it will be more costly to hire the labor needed to work with that capital in period t+1. Similarly, if the current loan rate or real wage increases, the firm will reduce its current demand for labor (equation (I.12)).

To proceed towards a solution for the short-run aggregate supply function, assume that the production function takes the following form:

$$(I.13)\qquad Y_t = K_t^{\alpha}\, L_t^{(1-\alpha)} + N_t$$

Let us now focus on small deviations around the firm's steady-state level of output such that the stock of capital in period t equals its steady-state value. Using bars over a variable to denote its steady-state value and lower cap letters (with the exception of the interest rates) to denote the natural-log value of a variable, we obtain:

$$\text{(I.14)} \qquad y_t - \bar{y}_t = (1-\alpha)\,(l_t - \bar{l}_t) + n_t$$

since in the steady-state, $\bar{n}_t = 0$

Using equation (I.12), equation (I.14) becomes:

$$\text{(I.14')} \qquad y_t - \bar{y}_t = (1-\alpha)\left[l_1 \ln\left(\frac{W_t}{P_t}\right) + l_2 \ln\left(1+r_{b,t}\right) - \bar{l}_t\right] + n_t$$

Next, assume equilibrium in the labor market by equating the demand for labor (equation (I.12)) to the following classical supply of labor equation:

$$\text{(I.15)} \qquad L^s_t = L^s_t\left(\frac{W_t}{P_t}, \frac{1+r_{m,t}}{1+\pi_t}\right)$$

$$\text{with} \qquad \frac{\partial L^s_t}{\partial\left(W_t/P_t\right)} > 0 \quad \text{and} \quad \frac{\partial L^s_t}{\partial\left(\frac{1+r_{m,t}}{1+E\pi_t}\right)} > 0$$

where: $r_{m,t}$ is the interest rate paid on holdings of bank deposits and

$E\pi_t$ is the expected rate of inflation.

Totally differentiating the equation representing equilibrium in the labor market and solving for $d\left(\frac{W_t}{P_t}\right)$, we obtain:

$$\text{(I.16)} \qquad d\left(\frac{W_t}{P_t}\right) = -\frac{1}{A_1}\,\frac{\partial l}{\partial\left(1+r_{b,t}\right)}\,d\left(1+r_{b,t}\right) + \frac{1}{A_1}\,\frac{\partial L^s_t}{\partial\left(\frac{1+r_{m,t}}{1+E\pi_t}\right)}\,d\left(\frac{1+r_{m,t}}{1+E\pi_t}\right)$$

where: $A_1 = \frac{\partial l}{\partial \left(\frac{W_t}{P_t}\right)} - \frac{\partial L^s}{\partial \left(\frac{W_t}{P_t}\right)} < 0$

From equation (I.16) we postulate the following semi-log-linear version of the real wage rate equation:

$$\text{(I.17)} \qquad \ln\left(\frac{W_t}{P_t}\right) = \delta_3 - \delta_4 r_{b,t} - \delta_5 r_{m,t} + \delta_5\left(Ep_{t+1} - p_t\right)$$

with = δ_4, $\delta_5 > 0$

Finally, substituting equation (I.17) into equation (I.14), we obtain the aggregate supply function under no credit rationing

$$\text{(I.18)} \qquad y_t - \bar{y}_t = \mu_3 - \mu_4 r_{b,t} + \mu_5 r_{m,t} - \mu_5\left(Ep_{t+1} - p_t\right) + n_t$$

with μ_4, $\mu_5 > 0$

2. Credit rationing

If the firm is confronted with credit rationing, then the amount that it can borrow must equal the available supply of funds (B_t^s)

$$B_t < B_t^s$$

In this case, the firm's optimization problem becomes:

$$\text{(I.19)} \qquad V(.t) = \max_{\{C_t,\, K_{t+1},\, L_t\}} E\left(U_t + \beta V(.t+1)\right) + \lambda_t\left(\frac{W_t L_t}{P_t} - \frac{B_t^s}{P_t}\right)$$

and λ is a Lagrange multiplier.

As the credit rationing constraint is assumed to be binding, the demand for labor becomes

(I.20) $$L_t = \frac{B_t^s}{P_t} \frac{P_t}{W_t}$$

As a result, diviations of output from its steady-state position takes the following form (in log form):

(I.21) $$y_t - \bar{y}_t = (1-\alpha)\ [b_t^s - p_t - \ln\left(\frac{W_t}{P_t}\right) - \bar{\ell}] + n_t$$

once again, equating the demand for labor function to the supply of labor function; totally differentiating the resulting equation and solving for $d\left(\frac{W_t}{P_t}\right)$ we obtain:

(I.22) $$d\left(\frac{W_t}{P_t}\right) = \frac{1}{A_2}\, d\left(\frac{B_t^s}{P_t}\right) - \frac{1}{A_2}\, \frac{W_t}{P_t}\, \frac{\partial L^s}{\partial\left(\frac{1+r_{m,t}}{1+E\pi_t}\right)}\, d\left(\frac{1+r_{m,t}}{1+E\pi_t}\right)$$

where $A_2 = 1 + \frac{W_t}{P_t} \frac{\partial L^s}{\partial (W_t/P_t)} > 1$

Therefore, we can postulate the following semi-log linear version of the real wage equation:

(I.23) $$\ln\left(\frac{W_t}{P_t}\right) = \delta_0 + \delta_1\left(b_t^s - p_t\right) - \delta_2\left(r_{m,t} - Ep_{t+1} + p_t\right)$$

with $\delta_1,\ \delta_2 > 0$

Finally, substituting equation (I.23) into equation (I.21), we obtain the aggregate supply function under credit rationing (in log-form):

(I.24) $$y_t - \bar{y}_t = \mu_0 + \mu_1\left(b_t^s - p_t\right) + \mu_2\left(r_{m,t} - Ep_{t+1} + p_t\right) + n_t$$

Derivation of the Risk Premium Equation

As stated in Appendix I, the probability of non-default (Q_t) is given by:

$$\text{(II.1)} \qquad Q_t = \int_{N_t^*}^{\infty} g\left(N_t\right) d\, N_t$$

where $N_t^* = \left(1+r_{b,t}\right) \left(W_t/P_t\right) L_t - f_t \left(K_t, L_t\right)$

1. Credit rationing case

Under credit rationing the demand for labor is given by:

$$L_t = \frac{B_t^s}{P_t} \frac{P_t}{W_t}$$

As a result, totally differentiating equation (II.1) in the neighborhood of the steady-state, i.e., assuming dK = 0

$$\text{(II.2)} \qquad dQ_t = -g\left(N_t^*\right) \left[\frac{B_t^s}{P_t} d \left(1+r_{b,t}\right) + \left(1+r_{b,t}\right) d \left(\frac{B_t^s}{P_t}\right) - \frac{\delta f_t}{\delta L_t} \left(\frac{P_t}{W_t} d\left(\frac{B_t^s}{P_t}\right) - \frac{B_t^s}{P_t} d\left(\frac{W_t}{P_t}\right)\right)\right]$$

However, from equation (I.23) of Appendix I we know that

$$\text{(II.3)} \qquad \ln\left(\frac{W_t}{P_t}\right) = \delta_0 + \delta_1 \left(\frac{B_t^s}{P_t}\right) - \delta_2 \left(r_{m,t} - Ep_{t+1} + p_t\right)$$

Using equation (II.3) we can rewrite equation (II.2) as:

$$\text{(II.4)} \qquad dQ = -g \left(N_t^*\right) \{\frac{B_t^s}{P_t} d\left(1+r_{b,t}\right)$$

$$+ \left[\left(1+r_{b,t}\right) - \frac{\partial f}{\partial L_t}\frac{P_t}{W_t} + \frac{\partial f}{\partial L_t}\frac{B^s_t}{P_t}\frac{\partial\left(\frac{W_t}{P_t}\right)}{\partial\left(\frac{B^s_t}{P_t}\right)}\right] d\left(\frac{B^s_t}{P_t}\right)$$

$$+ \left[\frac{\partial f_t}{\partial L_t}\frac{B^s_t}{P_t}\frac{\partial\left(\frac{W_t}{P_t}\right)}{\partial\left(\frac{1+r_{m,t}}{1+\pi_t}\right)}\right] d\left(\frac{1+r_{m,t}}{1+\pi_t}\right)$$

Based on equation (II.4), we postulate the following semi-log linear form for the risk premium (or probability of default): $\rho = 1 - Q$ under credit rationing:

(II.5) $\rho = \gamma_0 + \gamma_1 r_{b,t} - \gamma_2 (r_{m,t} - Ep_{t+1} + p_t) + \gamma_3 (b^s_t - p_t)$

with $\gamma_1, \gamma_2, \gamma_3 > 0$

2. Noncredit rationing case

Under noncredit rationing, the demand for labor is given by:

$$L_t = l_t\left(\frac{W_t}{P_t}, 1 + r_{b,t}\right).$$

As a result, totally differentiating equation (II.1), we obtain:

(II.6) $$dQ_t = -g(N^*_t)\left\{\frac{W_t}{P_t} L_t\, d(1 + r_{b,t})\right.$$

$$+ (1+r_{b,t})\frac{W_t}{P_t}\left(\frac{\partial l}{\partial\left(\frac{W_t}{P_t}\right)} d\left(\frac{W_t}{P_t}\right) + \frac{\partial l}{\partial(1+r_{b,t})} d(1+r_{b,t})\right)\Bigg\}$$

$$+ (1+r_{b,t}) L_t\, d\left(\frac{W_t}{P_t}\right)$$

$$- \frac{\partial f_t}{\partial L} \left\{ \frac{\partial l}{\partial \left(\frac{W_t}{P_t} \right)} d \left(\frac{W_t}{P_t} \right) + \frac{\partial l}{\partial (1+r_{b,t})} d\,(1+r_{b,t}) \right\}$$

but, in this noncredit rationing case, the first order condition of the firm's maximization problem implies (see Appendix I):

$$\text{(II.7)} \qquad (1 + r_{b,t}) \frac{W_t}{P_t} - \frac{\partial f_t}{\partial L_t} = 0$$

Also from equation (I.17) of Appendix I, we know that:

$$\text{(II.8)} \qquad \ln \left(\frac{W_t}{P_t} \right) = \delta_3 + \delta_4 r_{b,t} - \delta_5 (r_{m,t} - Ep_{t+1} + p_t)$$

Using equations (II.7) and (II.8), equation (II.6) can be rewritten as follows:

$$\text{(II.9)} \qquad dQ_t = -g(N_t^*) \left\{ \left[\frac{W_t}{P_t} L_t + (1+r_{b,t}) L_t \frac{\partial \left(\frac{W_t}{P_t} \right)}{\delta (1+r_{b,t})} d(1+r_{b,t}) \right. \right.$$

$$+ \left[(1+r_{b,t}) L_t \frac{\partial \left(\frac{W_t}{P_t} \right)}{\partial \left(\frac{1+r_{m,t}}{1+\pi_t} \right)} \right] d \left(\frac{1+r_{m,t}}{1+\pi_t} \right)$$

Based on equation (II.9), we postulate the following semi-log linear form for the risk premium (or probability of default under no credit rationing:

$$\text{(II.10)} \qquad \rho = \gamma_4 + \gamma_5 r_{b,t} - \gamma_6 (r_{m,t} - Ep_{t+1} + p_t)$$

with γ_5, $\gamma_6 > 0$.

The Solutions for the Fully Controlled Capital Markets Economy and the Partially Liberalized Economy Facing Credit Rationing

These cases are represented by equations (1a), (2), (3), (4), (5), and (6) of the main text, and by assuming that the deposit interest rates is fixed at levels determined by the monetary authorities. That is: $r_{m,t} = \bar{r}_m$. In the case of fully controlled capital markets, two additional assumptions need to be added: (1) the value of ψ equals one since there is no foreign borrowing and, therefore, the supply of credit is fully accounted for by the monetary base; and (2) the loan deposit rate is also determined by the monetary authorities. That is, $r_{b,t} = \bar{r}_b$. This last assumption, however, makes no difference to the results because the loan rate is not an argument in the supply of output and in the money demand equations.

Even in these cases, equilibrium in the money market is achieved because the exchange rate is allowed to adjust. Assuming that the exogenous variables (p^* and r_m) are constant over time and solving the model for the exchange rate yields:

$$\text{(III.1)} \qquad s_t = \frac{1}{A_2} \begin{cases} -\ (k - (1-\mu_1\psi)\ \bar{h} + \mu_0 + \psi\mu j + \bar{y} + \mu_1(1-\psi)\bar{f}) \\ -\ (1-\mu_1)\ p_t^* \\ -\ (1-\mu_1 + \mu_2 + \eta_1)\ \varepsilon_t \\ +\ (\mu_2 + \eta_1)\ E(s_{t+1}) \\ -\ (\mu_2 + \eta_1)\ \bar{r}_m \\ -\ n_t - v_t \end{cases}$$

where $A_2 = 1 + \phi - \mu_1\ (1+\psi\phi) + \mu_2 + \eta_1$

By the method of undetermined coefficients we postulate:

$$\text{(III.2)} \qquad s_t = S_0 + S_1\ \bar{p}^* + S_2\varepsilon_t + S_3\ \bar{r}_m + S_4\ n_t + S_5\ v_t$$

updating equation (III.2) and taking expectations yields:

(III.3) $E\ (s_{t+1}) = S_0 + S_1\ \bar{p}^* + S_3 \bar{r}_m$

The solution for the undetermined coefficients are:

$$S_1 = \frac{-\ (1-\mu_1)}{A_2 - \mu_2 - \eta_1} < 0$$

$$S_2 = -(1-\mu_1+\mu_2+\eta_1)/A_2 \quad < 0$$

$$S_3 = \frac{-\ (\mu_2+\eta_1)}{A_2 - \mu_2 - \eta_1} < 0$$

$$S_4 = S_5 = -1/A_2 < 0$$

substituting these solutions into equation (1a) yields:

(III.4) $y_t = \bar{y} + a_0 + a_1\ \varepsilon_t + a_2\ v_t + a_3\ n_t$

where $a_1 = \dfrac{\phi[\mu_2-\mu_1(1-\psi(1+\eta_1))]}{A_2}$

$$a_2 = \frac{(1+\phi)\mu_1-\mu_2}{A_2}$$

$$a_3 = \frac{1 + \phi + \eta_1}{A_2}$$

In order to choose the optimal level of foreign exchange intervention, two alternative objective functions are used:

1. Minimizing the variance of output around its steady state level

Assume that the authorities' objective function ($Z_{1,t}$) is:

(III.5) $Z_{1,t} = E\ (y_t - \bar{y})^2$

Their problem is then to choose ϕ in order to minimize equation (III.5). The first order condition from this optimization problem is:

$$\text{(III.6)} \qquad \frac{\partial Z_{1,t}}{\partial \phi} = 2\, a_1 \frac{\partial a_1}{\partial \phi} \sigma_\varepsilon^2 + 2a_2 \frac{\partial a_2}{\partial \phi} \sigma_v^2 + 2a_3 \frac{\partial a_3}{\partial \phi} \sigma_n^2 = 0$$

From equation (III.6), the optimal exchange rate intervention parameter (ϕ_y^*) equals:

$$\text{(III.7)} \qquad \phi_y^* = \frac{(\mu_1-\mu_2)\, \sigma_v^2 - (1+\eta_1)\, \sigma_n^2}{[(\mu_2-\mu_1(1-\psi(1+\eta_1))\ (1-\mu_1+\mu_2+\eta_1)]\sigma_\varepsilon^2 + \mu_1\psi\, \sigma_v^2 + \sigma_n^2}$$

and

$$\frac{\partial\, \phi_y^*}{\partial\, \sigma_\varepsilon^2} < 0 \text{ if } \mu_2 > \mu_1 \text{ and } \phi_y^* > 0$$

$$\frac{\partial\, \phi_y^*}{\partial\, \sigma_v^2} > 0 \text{ if } \mu_2 > \mu_1, < 0 \text{ if } \mu_1 > \mu_2 \text{ and } \sigma_n^2 \text{ small}$$

$$\frac{\partial\, \phi_y^*}{\partial\, \sigma_n^2} < 0$$

2. Minimizing the variance of the price level

Assume that the authorities' objective function ($Z_{2,t}$) takes the following form:

$$\text{(III.8)} \qquad Z_{2,t} = E\ (p_t - E(p_t))^2$$

Then, the problem becomes to choose ϕ such as to minimize equation (III.8). Using equation (2) from the main text and equation (III.2), the first order condition yields:

$$\text{(III.9)} \quad \frac{\partial Z_{2,t}}{\partial \phi} = 2\ ((1+S_2)\frac{\partial S_2}{\partial \phi} \quad \sigma_{\varepsilon}^2$$

$$+ 2S_4 \frac{\partial S_4}{\partial \phi} \sigma_n^2 \ + 2S_5 \frac{\partial S_5}{\partial \phi} \sigma_v^2 = 0$$

From equation (III.9), the optimal exchange rate intervention parameter (ϕ_p^*) equals:

$$\text{(III.10)} \quad \phi_p^* = \frac{\left(\sigma_v^2 + \sigma_n^2\right)}{(1-\mu_1+\mu_2+\eta_1)\ (1-\mu_1\psi)\ \sigma_{\varepsilon}^2}$$

and:

$$\frac{\partial \phi_p^*}{\partial \sigma_{\varepsilon}^2} = \frac{-\ (\sigma_v^2 + \sigma_n^2)}{(1-\mu_1+\mu_2+\eta_1)\ (1-\mu_1\psi)(\sigma_{\varepsilon}^2)^2} < 0$$

$$\frac{\partial \phi_p^*}{\partial \sigma_v^2} = \frac{\partial \phi_p^*}{\partial \sigma_n^2} = \frac{1}{(1-\mu_1+\mu_2+\eta_1)\ (1-\mu_1\psi)\ \sigma_{\varepsilon}^2} > 0$$

The Case of Partial Removal of International Capital Controls and Partial Liberalization of Domestic Interest Rates in an Economy with No Credit Rationing

This case is represented by equations (1b), (2), (3), (5)-(8), and (9b) of the main text and by the assumption that the domestic deposit rate is fixed by the monetary authorities.

Under the assumption that the exogenous variables are constant over time, this system of equations yields the following solutions for the exchange rate and the loan rate:

(IV.1) $$s_t = \text{constant} - \left[\frac{(1+\mu_1+\eta_1)(1-(1+\theta)\gamma_5) + \mu_4(1+\theta)\gamma_6}{A_3}\right]\epsilon_t$$

$$\frac{-(1-(1+\theta)\gamma_5)}{A_3}(n_t+v_t) + \frac{\mu_4(1+\theta)}{A_3}g_t$$

(IV.2) $$r_{b,t} = \text{constant}$$

$$+ \left[\frac{(1+\theta)(1+\mu_5+\eta_1-\phi\gamma_6)}{A_3}\epsilon_t\right]$$

$$+ \frac{(1+\gamma_6)(1+\theta)}{A_3}(n_t+v_t) + \frac{(1+\theta)(1+\phi+\mu_5+\eta_1)}{A_3}g_t$$

where $A_3 = (1-(1+\theta)\gamma_5)(1+\phi+\mu_5+\eta_1) + \mu_4(1+\gamma_6)(1+\theta) > 0$

Substituting these solutions into equation (1b) yields:

(IV.3) $$y_t = \bar{y} + b_0 + b_1\epsilon_t + b_2 v_t + b_3 n_t + b_4 g_t$$

where $b_1 = \dfrac{[\mu_5(1-(1+\theta)\gamma_5)\phi - \mu_4(1+\theta)(1+\eta_1-\phi\gamma_6)}{A_3}$

$$b_2 = - \left[\frac{\mu_4(1+\gamma_6)(1+\theta) + \mu_5(1-(1+\theta)\gamma_5)}{A_3}\right]$$

$$b_3 = - \left[\frac{\mu_4(1+\gamma_6)(1+\theta) + \mu_5(1-(1-\theta)\gamma_5)}{A_3}\right] + 1$$

$$b_4 = - \frac{\mu_4(1+\theta)\ (1+\eta_1)}{A_3}$$

1. Minimizing the variance of output around its steady state level

The problem is to choose ϕ in order to minimize equation (11) in the main text. The first order condition from this optimization problem is:

$$\text{(IV.4)} \quad \frac{\partial Z_{1,t}}{\phi} = 2\ b_1 \frac{\partial b_1}{\partial \phi} \sigma_\epsilon^2 + 2\ b_2 \frac{\partial b_2}{\partial \phi} \sigma_v^2$$

$$+ 2\ b_3 \frac{\partial b_3}{\partial \phi} \sigma_n^2 + 2b_4 \frac{\partial b_4}{\partial \phi} \sigma_g^2 = 0$$

From equations (IV.3) and (IV.4), the optimal exchange rate intervention parameter (ϕ_y^*) equals:

$$\text{(IV.5)} \quad \phi_y^* = \frac{B_1}{B_2}$$

where:

$$B_1 = \mu_4\ (1+\theta)(1+\eta_1)\ z_1\ \sigma_\epsilon^2 - z_2\ \sigma_v^2 - z_3\ \sigma_n^2 - z_4\ \sigma_g^2$$

$$B_2 = [\mu_5\ (1-(1+\theta)\ \gamma_5) + \mu_4\ (1+\theta)\ \gamma_6]\ z_1\ \sigma_\epsilon^2$$

$$-(1-\gamma_5\ (1+\theta))^2\ z_5\ \sigma_n^2 + \mu_4^2\ (1+\theta)^2\ z_5\ \sigma_g^2]$$

and:

$$z_1 = z_5\ [1+\eta_1-\gamma_5\ (1+\eta_1+\theta(1+\eta_1)) + \mu_4\ \gamma_6\ (1+\theta) + \mu_5\ (1-\gamma_5(1+\theta))]$$

$$z_2 = -[1-\gamma_5 (1+\theta)] z_5^2$$

$$z_3 = (1-\gamma_5 (1+\theta))^2 (1+\eta_1) z_5$$

$$z_4 = \mu_4^2 (1+\theta)^2 (1+\eta_1) z_5$$

$$z_5 = [\mu_4 (1+\gamma_6) (1+\theta) + \mu_5 (1-\gamma_5(1+\theta))]$$

Also:

$$\frac{\partial \phi_y^*}{\partial \sigma_\epsilon^2} = \frac{1}{B_2^2} \{B_2[\mu_4(1+\theta)(1+\eta_1) z_1] - B_1[\mu_5 (1-(1+\theta)\gamma_5) + \mu_4(1+\theta) \gamma_6] z_1\}$$

> 0 if σ_g^2 and σ_v^2 are dominant in the system

$$\frac{\partial \phi_y^*}{\partial \sigma_v^2} = -\frac{z_2}{B_2} > 0$$

$$\frac{\partial \phi_y^*}{\partial \sigma_n^2} = \frac{1}{B_2^2} \{ - z_3 B_2 + (1-\gamma_5 (1+\theta))^2 z_5 B_1\}$$

< 0 unless σ_ϵ^2 dominates the system

$$\frac{\partial \phi_y^*}{\partial \sigma_g^2} = \frac{1}{B_2^2} \{- z_4 B_2 - \mu_4^2 (1+\theta)^2 z_5 B_1\}$$

< 0 if σ_ϵ^2 and σ_v^2 dominate the system

2. Minimizing the variance of the price level

The problem is to choose ϕ in order to minimize equation (12) in the main text. Using equation (2) from the main text and equation (IV.1), the first order condition yields:

$$\text{(IV.6)} \quad \frac{\partial Z_{2,t}}{\partial \phi} = -2(1-S_1)\frac{\partial S_1}{\partial \phi}\sigma_\epsilon^2$$

$$- 2 S_2 \frac{\partial S_2}{\partial \phi}(\sigma_v^2+\sigma_n^2) + 2 S_3 \frac{\partial S_3}{\partial \phi}\sigma_g^2 = 0$$

where:

$$S_1 = [(1+\mu_1+\eta_1)(1-(1+\theta)\gamma_5) + \mu_4 (1+\theta)\gamma_6]/A_3$$

$$S_2 = (1-(1+\theta)\gamma_5)/A_3$$

$$S_3 = \mu_4 (1+\theta)/A_3$$

From equation (IV.6), the optimal exchange rate intervention parameter (ϕ_y^*) equals:

$$\text{(IV.7)} \quad \phi_p^* = \frac{B_3}{B_4}$$

where:

$$B_3 = - z_6 [z_6 + 2\mu_4 (1+\theta)] \sigma_\epsilon^2 + [1-\gamma_5 (1+\theta)]^2 (\sigma_v^2+ \sigma_n^2)$$

$$+ [\mu_4^2 (1+\theta)^2] \sigma_g^2$$

$$B_4 = [2 z_6 (1-\gamma_5) (1+\theta))] \sigma_\epsilon^2$$

$$z_6 = 1 + \eta_1 - \gamma_5 (1+\eta_1+ \theta(1+\eta_1)) + \mu_4\gamma_6 (1+\theta) + \mu_5(1-\gamma_5(1+\theta))]$$

and:

$$\frac{\partial \phi_p^*}{\partial \sigma_\epsilon^2} = \frac{1}{B_4^2} \{- 2 z_5 (1-\gamma_5(1+\theta))^3(\sigma_v^2 + \sigma_n^2)$$

$$- 2 z_5(1-\gamma_5(1+\theta)) \mu_4^2(1+\theta)^2 \sigma_g^2\}$$

$$< 0$$

$$\frac{\partial \phi_p^*}{\partial \sigma_n^2} = \frac{\partial \phi_p^*}{\partial \sigma_v^2} = \frac{(1-(1+\theta)\gamma_5)^2}{B_4} > 0$$

$$\frac{\partial \phi_p^*}{\partial \sigma_g^2} = \frac{\mu_4^2 (1+\theta)^2}{B_4} > 0$$

The Case of Fully Liberalized Financial Markets in an Economy Facing Credit Rationing

This case is represented by equations (1a), (2) through (8), (9a), and (10) of the main text; and by the assumption that $\theta = 0$.

Assuming once more that the exogenous variables are constant over time, this system of equations yields the following solutions for the exchange rate and the loan rate:

(V.1) $s_t = \text{constant} + S_1\varepsilon_t + S_2 v_t + S_3 n_t + S_4 g_t + S_5 \chi_t$

where:

$$S_1 = \frac{(\gamma_2+\gamma_3)(\mu_2 + \eta_1)-(1-\mu_1+\mu_2+\eta_1)(1-\gamma_1+\gamma_2)}{A_4}$$

$$S_2 = S_3 = -[1-\gamma_1+\gamma_2]/A_4$$

$$S_4 = -[\mu_2+\eta_1]/A_4$$

$$S_5 = [\gamma_2(\mu_2+\eta_1)-(\mu_2+\eta_1)(1-\gamma_1+\gamma_2)]/A_4$$

and

$$A_4 = [1+\phi+\mu_2+\eta_1-\mu_1\psi_1(1+\phi)][1-\gamma_1+\gamma_2]-[(\mu_2+\eta_1)\gamma_3\psi]$$

(V.2) $r_{b,t} = \text{constant} + R_1\varepsilon_t + R_2 v_t + R_3 n_t + R_4 g_t + R_5 \chi_t$

where:

$$R_1 = \frac{(1-\mu_1+\mu_2+\eta_1)(\gamma_3\psi)(1-\gamma_1+\gamma_2)-(\gamma_2+\gamma_3)(1+\phi+\mu_2+\eta_1-\mu_1\psi(1+\phi)}{A_4}$$

$$R_2 = R_3 = [\gamma_3\psi(1-\gamma_1+\gamma_2)]/A_4$$

$$R_4 = [1+\phi+\mu_2+\eta_1-\mu_1\ \psi\ (1+\phi)]/A_4$$

$$R_5 = \frac{[(\mu_2+\eta_1)(\gamma_3\psi)(1-\gamma_1+\gamma_2) - \gamma_2(1+\phi+\mu_2+\eta_1-\mu_1\psi\ (1+\phi))]}{A_4}$$

Substituting these solutions into equation (1a) yields:

$$\text{(V.3)} \qquad y_t = \bar{y} + c_0 + c_1\ \varepsilon_t + c_2 v_t + c_3 n_t + c_4 g_t + c_5\ \chi_t$$

where:

$$c_1 = \mu_2 R_1 - (\mu_1\psi\phi + \mu_1\psi-\mu_2)S_1 - (\mu_1-\mu_2)$$

$$c_2 = \mu_2 R_2 - (\mu_1\psi\phi + \mu_1\psi - \mu_2)S_2$$

$$c_3 = 1 + \mu_2 R_3 - (\mu_1\psi\phi + \mu_1\psi-\mu_2)S_3$$

$$c_4 = \mu_2 R_4 - (\mu_1\psi\phi + \mu_1\psi-\mu_2)S_4$$

$$c_5 = \mu_2 + \mu_2\ R_5 - (\mu_1\psi\phi + \mu_1\psi - \mu_2)S_5$$

1. Minimizing the variance of the price level

The problem is to choose ϕ in order to minimize equation (12) in the main text. Using equation (2) from the main text and equation (V.1), the first order condition yields:

$$\text{(V.4)} \qquad \frac{\partial Z_{2,t}}{\partial \phi} = 2\ (1+S_1)\frac{\partial S_1}{\partial \phi}\sigma_\varepsilon^2 + 2\ S_2\frac{\partial S_2}{\partial \phi}\sigma_v^2 + 2\ S_3\frac{\partial S_3}{\partial \phi}\sigma_n^2 + 2\ S_4\frac{\partial S_4}{\partial \phi}\sigma_g^2 + 2\ S_5\frac{\partial S_5}{\partial \phi}\sigma_\chi^2 = 0$$

From equation (V.4), the optimal exchange rate intervention parameter (ϕ_p^*) equals:

(V.5) $$\phi_p^* = \frac{B_5}{B_6}$$

where

$$B_5 = -[(\eta_1 + \mu_2)\ \Gamma\ (S_1\ A_4)]\ \sigma_\varepsilon^2$$

$$+ [(\eta_1 + \mu_2)^2\Gamma]\ \sigma_g^2$$

$$+ [(1-\gamma_1+\gamma_2)(\psi(\eta_1\gamma_3+\mu_1-\gamma_1\mu_1 + \gamma_2\mu_1 + \gamma_3\mu_2) - (1-\gamma_1+\gamma_2))]\ (\sigma_v^2+\sigma_n^2)$$

$$+ [\Gamma(\gamma_1-1)^2(\eta_1 + \mu_2)^2]\ \sigma_\chi^2$$

$$B_6 = [\Gamma^2\ S_1\ A_4]\ \sigma_\varepsilon^2$$

$$\Gamma = (-1 + \gamma_1 - \gamma_2 + \eta_1\ \gamma_3\psi + \mu_1\psi - \gamma_1\ \mu_1\ \psi + \gamma_2\ \mu_1\ \psi + \gamma_3\ \mu_2\psi)$$

and:

$$\frac{\partial\phi_p^*}{\partial\sigma_\varepsilon^2} < 0 \text{ if } S_1 > 0$$

$$\frac{\partial\phi_p^*}{\partial\sigma_v^2} = \frac{\partial\phi_p^*}{\partial\sigma_n^2} > 0 \text{ if } S_1 > 0$$

$$\frac{\partial\phi_p^*}{\partial\sigma_g^2} > 0 \text{ if } S_1 > 0$$

$$\frac{\partial\phi_p^*}{\partial\sigma_\chi^2} > 0 \text{ if } S_1 > 0$$

The Case of Fully Liberalized Financial Markets in an Economy with No Credit Rationing

This case is represented by equations (1b), (2), (3), (5) through (8), (9b) and (10) of the main text and by the assumption that $\theta = 0$.

This system of equations yields the following solutions for the exchange rate and the loan rate:

$$\text{(VI.1)} \qquad S_t = \text{constant} + S_1\, \varepsilon_t + S_2\, v_t + S_3\, n_t + S_4\, g_t + S_5\, \chi_t$$

where

$$S_1 = \frac{\gamma_6\,(\mu_5-\mu_4+\eta_1) - (1+\mu_5+\eta_1)(1-\gamma_5+\gamma_6)}{A_5}$$

$$S_2 = S_3 = -[1-\gamma_5+\gamma_6]/A_5$$

$$S_4 = -\,[\mu_5-\mu_4+\eta_1]/A_5$$

$$S_5 = [\gamma_6(\mu_5-\mu_4+\eta_1) - (\mu_5+\eta_1)(1-\gamma_5+\gamma_6)]/A_5$$

and

$$A_5 = (1-\gamma_5+\gamma_6)(1+\phi+\mu_5+\eta_1) - (1+\gamma_6)(\mu_5-\mu_4+\eta_1)]$$

$$\text{(VI.2)} \qquad r_{b,t} = \text{constant} + R_1\, \varepsilon_t + R_2\, v_t + R_3\, n_t + R_4\, g_t + R_5\, \chi_t$$

where:

$$R_1 = [1+\mu_5+\eta_1-\phi\gamma_6]/A_5$$

$$R_2 = R_3 = [1+\gamma_6]/A_5$$

$$R_4 = [1+\phi+\mu_5+\eta_1]/A_5$$

$$R_5 = [(1+\gamma_6)(\mu_5+\eta_1) - \gamma_6(1+\phi+\mu_5+\eta_1)]/A_5.$$

Substituting these solutions into equation (1b) yields:

$$\text{(VI.3)} \qquad y_t = \bar{y} + d_0 + d_1\, \varepsilon_t + d_2\, v_t + d_3\, n_t + d_4\, g_t + d_5\, \chi_t$$

where:

$$d_1 = \mu_5 S_1 - (\mu_4 - \mu_5)R_1 + \mu_5$$

$$d_2 = \mu_5 S_2 - (\mu_4 - \mu_5)R_2$$

$$d_3 = 1 + \mu_5 S_3 - (\mu_4 - \mu_5)R_3$$

$$d_4 = \mu_5 S_4 - (\mu_4 - \mu_5)R_4$$

$$d_5 = \mu_5 + \mu_5 S_5 - (\mu_4 - \mu_5)R_5$$

1. Minimizing the variance output around its steady-state value

The problem is to choose ϕ in order to minimize equation (11) in the main text. The first order condition from this optimization problem is:

$$\text{(VI.4)} \qquad \frac{\partial Z_{1,t}}{\partial \phi} = 2d_1 \frac{\partial d_1}{\partial \phi} \sigma_\varepsilon^2 + 2d \frac{\partial d_2}{2\partial \phi} \sigma_v^2$$

$$+ 2d_3 \frac{\partial d_3}{\partial \phi} \sigma_n^2 + 2d_4 \frac{\partial d_4}{\partial \phi} \sigma_g^2 + 2d_5 \frac{\partial d_5}{\partial \phi} \sigma_\chi^2 = 0$$

From equations (VI.3) and (VI.4), the optimal exchange rate intervention parameter (ϕ_y^*) equals:

$$\text{(VI.5)} \qquad \phi_y^* = \frac{B_7}{B_8}$$

where:

$$B_7 = [(1+\gamma_6)(\mu_4 + \eta_1\mu_4 - \mu_5)\ (1+\eta_1-\gamma_5-\eta_1\gamma_5 + \gamma_6 + \gamma_6\mu_4 + \mu_5-\gamma_5\mu_5)]\sigma_\varepsilon^2$$

$$+ [(1-\gamma_5+\gamma_6)(\mu_4 + 2\gamma_6\mu_4 - \gamma_5\mu_5 - \gamma_6\mu_5)]\sigma_v^2$$

$$- [(-1+\gamma_5 - \gamma_6)(-1+\gamma_5 + \eta_1\gamma_5 - \gamma_6 + \eta_1\gamma_6))]\sigma_n^2$$

$$+ [(\eta_1 - \mu_4 + \mu_5)(\mu_4 + \eta_1\mu_4 - \mu_5)]\sigma_g^2$$

$$+ [(\eta_1\gamma_6-\gamma_6\mu_4 - \mu_5 + \gamma_5\mu_5)(\gamma_6\mu_4 + \eta_1\gamma_6\mu_4 + \mu_5 -\gamma_5\mu_5 -\eta_1\gamma_5\mu_5 -\eta_1\gamma_6\mu_5)]\sigma_\chi^2$$

$$B_8 = [(\gamma_6\mu_4 + \mu_5 - \gamma_5\mu_5)(1+\eta_1-\gamma_5-\eta_1\gamma_5 + \gamma_6 + \gamma_6\mu_4 +\mu_5 - \gamma_5\mu_5)]\sigma_\varepsilon^2$$

$$+ [-1 + \gamma_5 - \gamma_6]^2\ \sigma_n^2$$

$$+ [(\mu_4 - \mu_5)(-\eta_1 + \mu_4 - \mu_5)]\sigma_g^2$$

$$+ [(1-\gamma_6\mu_4 - \mu_5 + \gamma_5\mu_5)(\eta_1\gamma_6 - \gamma_6\mu_4 - \mu_5 + \gamma_5\mu_5)]\sigma_\chi^2$$

and:

$$\frac{\partial\phi_y^*}{\partial\sigma_\varepsilon^2} \gtrless 0$$

$$\frac{\partial\phi_y^*}{\partial\sigma_v^2} \gtrless 0$$

$$\frac{\partial\phi_y^*}{\partial\sigma_n^2} \gtrless 0$$

$$\frac{\partial \phi_y^*}{\partial \sigma_g^2} \gtrless 0$$

$$\frac{\partial \phi_y^*}{\partial \sigma_\chi^2} \gtrless 0$$

2. Minimizing the variance of the price level

The problem is to choose ϕ in order to minimize equqation (12) in the main text. Using equation 2 from the main text and equation (VI.1), the first order condition yields:

$$\text{(VI.6)} \quad \frac{\partial Z_{2,t}}{\partial \phi} = 2(1+S_1)\frac{\partial S_1}{\partial \phi}\sigma_\varepsilon^2 + 2S_2\frac{\partial S_2}{\partial \phi}\sigma_v^2 + 2S_3\frac{\partial S_3}{\partial \phi}\sigma_n^2 + 2S_4\frac{\partial S_4}{\partial \phi}\sigma_g^2 + 2S_5\frac{\partial S_5}{\partial \phi}\sigma_\chi^2 = 0$$

From equation (VI.6), the optimal exchange rate intervention paramater (ϕ_p^*) yields:

$$\text{(VI.7)} \quad \phi_p^* = \{[(1+\gamma_6)(\eta_1-\mu_4+\mu_5)(-1-\eta_1+\gamma_5+\eta_1\gamma_5-\gamma_6-\gamma_6\mu_4-\mu_5+\gamma_5\mu_5)]\sigma_\varepsilon^2$$

$$-(-1+\gamma_5-\gamma_6)^2\ (\sigma_v^2 + \sigma_n^2)$$

$$-(\eta_1-\mu_4 + \mu_5)^2\ \sigma_g^2$$

$$-(\eta_1\gamma_6-\gamma_6\mu_4 - \mu_5 + \gamma_5\ \mu_5)^2\sigma_\chi^2]\}/$$

$$-[(-1+\gamma_5-\gamma_6)(-1-\eta_1+\gamma_5+\eta_1\gamma_5-\gamma_6-\gamma_6\mu_4-\mu_5+\gamma_5\mu_5)]\sigma_\varepsilon^2$$

and $\phi_p^* > 0$ if $\mu_4 > \mu_5+\eta_1$.

Also:

$$\left.\begin{array}{ll} \dfrac{\partial\phi_p^*}{\partial\sigma_\varepsilon^2} & < 0 \\[2ex] \dfrac{\partial\phi_p^*}{\partial\sigma_v^2} = \dfrac{\partial\phi_p^*}{\partial\sigma_n^2} & > 0 \\[2ex] \dfrac{\partial\phi_p^*}{\partial\sigma_g^2} & > 0 \\[2ex] \dfrac{\partial\phi_p^*}{\partial\sigma_\chi^2} & > 0 \end{array}\right\} \begin{array}{l} \text{if } \mu_4 > \mu_5+\eta_1 \\[2ex] \text{undetermined otherwise} \end{array}$$

References

Aschauer, David, and Jeremy Greenwood, "A Further Exploration in the Theory of Exchange Rate Regimes," Journal of Political Economy, Vol. 91 (1983), pp. 868-875.

Basevi, Giorgio, "Multilateral Exchange Rate Determination: A Model for the Analysis of the European Monetary System," Université de Montréal, Departement de Science Economique et Centre de Recherche en Dévéloppement Economique, Cahier 8202 (1982).

Benavie, Arthur, "Achieving External and Internal Targets with Exchange Rate and Interest Rate Intervention," Journal of International Money and Finance, Vol. 2 (1983), pp. 75-85.

Bhandari, Jagdeep S. (1985a), "Informational Regimes, Economic Disturbances, and Exchange Rate Management," in Exchange Rate Management Under Uncertainty (Cambridge, Mass.: The MIT Press, 1985), pp. 126-153.

_____ (1985b), "World Trade Patterns, Economic Distrubances, and Exchange Rate Management," Journal of International Money and Finance, Vol. 4 (1985), pp. 331-360.

_____ (1985c), "Exchange Rate Management Under Uncertainty" (Cambridge, Mass.: The MIT Press, 1985).

Bryant, Ralph C, "International Financial Intermediation" (Washington: The Brookings Institution, 1987).

Calomiris, Charles Wand, and R. Glenn Hubbard, "Price Flexibility, Credit Availability, and Economic Fluctuations: Evidence from the United States, 1894-1909," Quarterly Journal of Economics, Vol. 54 (1989), pp. 429-52.

Carlozzi, Nicholas, and John B. Taylor, "International Capital Mobility and the Coordination of Monetary Rules," Exchange Rate Management Under Uncertainty, edited by Jagdeep S. Bhandari (Cambridge, Mass.: The MIT Press, 1985), pp. 186-221.

Cottarelli, Carlo, Giampaolo Galli, Paolo Marullo Reedtz, and Giovanni Pittaluga, "Credit Ceilings," Economic Policy, Vol. 3 (1986), pp. 673-695.

Daniel, Betty, "Optimal Foreign Exchange Policy for a Small Open Economy," Journal of International Money and Finance, Vol. 4 (1985), pp. 523-536.

The Delors Report, Report on Economic and Monetary Union in the EC (European Community, Luxembourg, August 1989).

Dooley, Michael, and Peter Isard, "Country Preferences, Currency Values and Policy Issues," Journal of Policy Modeling, No. 9 (1987), pp. 65-82.

Driskill, Robert, and Stephen A. McCafferty, "Exchange Market Intervention under Rational Expectations with Imperfect Capital Substitutability," in Exchange Rate Management Under Uncertainty, edited by Jagdeep S. Bhandari (Cambridge, Mass.: MIT Press, 1985), pp. 83-95.

Eaton, Jonathan, "Optimal and Time Consistent Exchange Rate Management in an Overlapping-Generations Model," Journal of International Money and Finance, Vol. 4 (1985), pp. 83-100.

Fleming, Marcus, "Domestic Financial Policies Under Fixed and Under Floating Exchange Rates," Staff Papers, Vol. 9 (Washington: International Monetary Fund, 1962), pp. 309-380.

Flood, Robert J., and Robert J. Hodrick, "Central Bank Intervention in a Rational Open Economy: A Model with Asymmetric Information," in Exchange Rate Management Under Uncertainty, edited by Jagdeep S. Bhandari (Cambridge, Mass.: MIT Press, 1985), pp. 154-185.

Folkerts-Landau, David, and Donald J. Mathieson, "Innovation, Institutional Changes, and Regulatory Response in International Financial Markets," in William S. Haraf and Rose Marie Kushmeider (editors), Restructuring Banking and Financial Services in America, American Enterprise Institute for Public Policy Research (Washington, 1988), pp. 392-423.

Frenkel, Jacob A., and Joshua Aizenman, "Aspects of the Optimal Management of Exchange Rates," Journal of International Economics, Vol. 13 (1982), pp. 231-256.

Harkness, Jon, "Optimal Exchange Intervention for a Small Open Economy," Vol. 4 (1985), pp. 101-112.

Helpman, Elhanan, "An Exploration in the Theory of Exchange Rate Regimes," Journal of Political Economy, Vol. 89 (1981), pp. 865-901.

_____, "Toward a Consistent Comparison of Alternative Exchange Rate Regimes," Canadian Journal of Economics, Vol. 12 (1979), pp. 394-409.

_____, and Assaf Razin, "Exchange Rate Management: Intertemporal Tradeoffs," American Economic Review, Vol. 77 (1987), pp. 107-123.

_____, "A Comparison of Exchange Rate Regimes in the Presence of Imperfect Capital Markets," International Economic Review, Vol. 23 (1982) pp. 365-88.

Hsieh, David A., "International Risk Sharing and the Choice of Exchange Rate Regime," Journal of International Money and Finance, Vol. 3 (1984), pp. 141-152.

Isard, Peter, Donald J. Mathieson, and Liliana Rojas-Suárez, "Financial Intermediation, Inflation, and Growth in Developing Countries" (unpublished, 1989).

Rojas-Suárez, E. Liliana, "Devaluation and Monetary Policy in Developing Countries: A General Equilibrium Model for Economies Facing Financial Constraints," Staff Papers, Vol. 34 (Washington, D.C.: International Monetary Fund, 1987), pp. 439-470.

Stiglitz, J., and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," The American Economic Review (June 1981), pp. 393-410.

Turnovsky, Stephen J., "Optimal Exchange Market Intervention: Two Alternative Classes of Rules," in Exchange Rate Management Under Uncertainty, edited by Jagdeep S. Bhandari (Cambridge, Mass.: The MIT Press, 1985), pp. 55-72.