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**Essays on Exchange Rate Regimes
and International Financial Crises**

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Essays on Exchange Rate Regimes and International Financial Crises

by

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In loving memory of Bruce D. Smith

***To: Scott Freeman, Valerie Bencivenga, Angel Hernandez, Maria Luisa Verme and
Manuel Hernandez-Verme***

Essays on Exchange Rate Regimes and International Financial Crises

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My dissertation examines international monetary arrangements, alternative exchange rate regimes and international financial crises. The first chapter focuses on alternative choices of exchange rate regimes for small open economies subject to financial market frictions. I compare the merits of various inflation stabilization policies implemented in Latin America (particularly Argentina and Perú). The second chapter focuses on financial crises and how they are transmitted under alternative international monetary mechanisms.

The third chapter investigates the relative merits of a policy of inflation targeting with floating exchange rates.

In the first chapter, I find that under floating exchange rates, the ability to raise domestic inflation above foreign inflation can increase production if credit is rationed. However, there is a limitation on the extent to which inflation can be used to stimulate production: if inflation is increased beyond a threshold level, a reduction in real activity is observed. Under either fixed or floating exchange rate regimes, the consequences of changes in domestic or foreign inflation can differ dramatically, depending on whether or not credit rationing is observed. Finally, instability, indeterminacy of dynamic equilibria and economic fluctuations may arise independently of the exchange rate regime. Private information –coupled with high rates of domestic inflation- increases the scope for indeterminacy and for economic fluctuations.

In the second chapter, I find that a common international currency and no legal restrictions on exchange help a financial periphery share reserves with a financial center (which has, relatively, more available reserves), mitigating the output losses due to financial crises. The center has incentives for restrictive rediscounting while the periphery has motives for developing central banking.

In the third chapter, I find that under a policy of inflation targeting, steady state equilibria replicate the equilibria under a (free) floating exchange rate regime. The scope for economic fluctuations can be typically reduced by a policy of inflation targeting, when compared to either a (free) floating exchange rate regime or a currency board.

However, the potential of this policy to improve on stability and/or on determinacy of dynamic equilibria seems to depend strongly on the probability of repaying loans in the economy.

Table of Contents

Introduction	1
 Chapter I: Inflation, Growth and Exchange Rate Regimes in Small Open Economies	 7
1 Introduction	9
2 A Flexible Exchange Rate Regime: The Peruvian Economy After the Stabilization	16
2.1 The Environment	16
2.1.1 Endowments	17
2.1.2 Informational Structure	19
2.2 Trading and Financial Intermediation	20
2.2.1 Credit Markets	23
2.3 Agents' Behavior and Factor Markets	23
2.4 Loan Contracts	25
2.5 A General Equilibrium	28
2.5.1 Equilibrium Conditions	30
2.6 Steady-State Equilibria	32
2.6.1 Steady-State Equilibria in a Walrasian Regime	33
2.6.2 Steady-State Equilibria in a Credit Rationing Regime	35
2.6.3 When Does Credit Rationing Occur?	38
2.7 Dynamic Equilibria	40
2.7.1 Dynamic System in a Walrasian Regime	40
2.7.2 Dynamic System in a Credit Rationing Regime	41
3 A Fixed Exchange Rate Regime: Argentina After the Stabilization	46
3.1 Government Policy	46
3.2 Stationary Equilibria	49
3.2.1 Steady-State Equilibria in a Walrasian Regime	50
3.2.2 Steady-State Equilibria in a Credit Rationing Regime	53
3.2.3 When Does Credit Rationing Occur?	58
3.3 Dynamic Equilibria	61

	3.3.1	Dynamic System in a Walrasian Regime	.....	61
	3.3.2	Dynamic System in a Credit Rationing Regime	.....	63
4		Conclusions	.....	69

Chapter II: Disruptions of Liquidity, International Financial Crises and Monetary Integration 72

1		Introduction	.....	74
2		A Single Currency World	.....	78
	2.1	Endowments, Preferences and Production	.....	78
	2.2	Interaction between Countries and Trade and Travel Patterns	.....	80
		2.2.1 Young Agents	.....	81
		2.2.2 Old Agents	.....	82
	2.3	Equilibrium	.....	84
		2.3.1 Behavior of Individual Agents	.....	84
		2.3.2 Market Clearing Conditions	.....	87
		2.3.3 General Equilibrium	.....	90
		2.3.4 Steady-State Equilibrium	.....	91
	2.4	Optimality	.....	92
		2.4.1 The Golden Rule	.....	92
		2.4.2 Integrated Competitive Equilibrium and The Golden Rule	.....	93
	2.5	Liquidity Shocks and Output	.....	95
	2.6	Policy	.....	98
		2.6.1 An Elastic Currency Regime: A Discount Window	.....	98
		2.6.2 Restrictive Lending by the Financial Center	.....	100
3		The Open Economy with Country-Specific Outside Currencies	.....	102
	3.1	Trade and Travel Patterns	.....	102
	3.2	Equilibrium and Optimality	.....	104
	3.3	Liquidity Shocks and Output	.....	106
4		Financial Crises under the International Gold Standard	.....	108
5		Conclusions	.....	111

Chapter III: Private Information and Inflation Targeting in Small Open Economies 113

1	Introduction	115
2	The Environment	121
2.1	Endowments	122
2.2	Informational Structure	123
2.3	Trading and Financial Intermediation	124
2.3.1	Credit Markets	127
2.4	Agent's Behavior and Factor Markets	128
2.5	Loan Contracts	129
3	A General Equilibrium and Government Policy	131
3.1	Government Policy	132
3.2	Equilibrium Conditions	134
4	Steady-State Equilibria	137
4.1	Steady-State Equilibria in a Walrasian Regime	137
4.2	Steady-State Equilibria with Credit Rationing	141
4.3	When Does Credit Rationing Occur?	146
5	Dynamic Equilibria	149
5.1	Dynamic System in a Walrasian Regime	149
5.1.1	Local Stability Analysis	150
5.2	Dynamic System in a Credit Rationing Regime	150
5.2.1	Local Stability Analysis	152
6	Conclusions	157
Figures		161
Tables		168
Appendix A: Technical Appendix for Chapter I		172
1	Proofs for Lemmas and Propositions in Section 2	172
2	Technical Notes on Local Stability Analysis in Section 2	181
3	Technical Notes on (Steady-State) Comparative Statics in Section 3	183
3.1	Steady-State Equilibria in a Walrasian Regime	183
3.1.1	Comparative Statics with respect to the Policy Parameters θ and ξ	183
3.1.2	Effects of Increases in σ^* , r , ϕ_d or ϕ_f on the capital-labor ratio ($\hat{k}$)	184
3.1.3	Effects of Increases in σ^* on both δ and $\hat{\chi}$	185

	3.1.4	Comparative Statics under a Currency Board	185
	3.1.5	Comparative Statics under a Pure Fixed Exchange Rate	188
	3.2	Steady-State Equilibria in a Credit Rationing Regime	189
	3.2.1	Comparative Statics with respect to the Policy Parameters θ and ξ	189
	3.2.2	Comparative Statics under a Currency Board	191
	3.2.3	Comparative Statics under a Pure Fixed Exchange Rate	203
	3.3	When Does Credit Rationing Occur?	208
	3.3.1	Case 1	210
	3.3.2	Case 2	210
4		Technical Notes on the Local Stability Analysis in Section 3	211
	4.1	The Dynamic System in a Walrasian Regime	211
	4.1.1	Local Stability under a Currency Board	212
	4.1.2	Local Stability under a Pure Fixed Exchange Rate Regime	213
	4.2	The Dynamic System in a Credit Rationing Regime	214
	4.2.1	Determinant of the Jacobian evaluated at the nontrivial steady-state	214
Appendix B: Technical Appendix for Chapter II			216
	1	Proof for Proposition 1	216
	2	Proof for Proposition 2	217
Appendix C: Technical Appendix for Chapter III. Alternative Fiscal Policies			218
	1	Alternative Fiscal Policy 1: To Give Equal Lump-sum Transfers to all Young Agents	218
	2	Alternative Fiscal Policy 2: To Give Transfers Specific to Young Agents of Each Type so that the Policy is Neutral	219
Bibliography			221
Vita			227

Introduction

My dissertation examines international monetary arrangements, alternative exchange rate regimes, inflation stabilizations and international financial crises. The first chapter of the dissertation focuses on alternative choices of exchange rate regimes for a small open economy subject to financial market frictions. Some of the intention is to consider the relative merits of various inflation stabilization policies that have been implemented in Latin America (particularly Argentina and Perú). The second chapter focuses on financial crises and how they are transmitted under alternative international monetary mechanisms. The third chapter investigates the relative merits of a policy of inflation targeting with floating exchange rates.

The title of the first chapter of my dissertation is “Inflation, Growth and Exchange Rate Regimes in Small Open Economies.” In this paper I investigate the relative merits of different exchange rate regimes along several dimensions, especially with respect to reductions in inflation, the promotion of financial deepening, and the avoidance of stagnation in output. A particular motivation for examining different exchange rate regimes is to think about alternative methods for stabilizing high rates of inflation in a small open economy.

Perú and Argentina experienced episodes of severe hyperinflation in the late 1980s and early 1990s, and both stabilization programs were successful in reducing inflation. Both programs had common aspects with respect to fiscal policies. However, the main difference, and the one I focus on in this paper, is the choice of exchange rate regime: Argentina implemented a fixed exchange rate regime with a currency board while in Perú the exchange rate was left to float freely, under the supervision of the Central Bank. I analyze a small open economy that captures several features of the Peruvian and Argentinean economies subsequent to their stabilizations, with financial intermediaries performing a real allocative function in the presence of credit market frictions that may or may not cause credit to be rationed. I then analyze the equilibria of two economies that are similar in all respects, except for their choice of exchange rate regime.

I find that in economies with floating exchange rates, changes in domestic inflation and world (U.S.) inflation affect the domestic capital stock differently according to whether or not credit is rationed. Interestingly –and, in marked contrast to the literature on closed economies- either credit rationing tends to be observed when domestic rates of inflation are low, or else the scope for credit to be rationed depends in a relatively complicated way on the rate of money creation (inflation). In the first situation, moderate increases in the rate of money growth (inflation) stimulate output when credit is rationed (inflation is initially low), but reduce output when there is no credit rationing (inflation is initially high). Thus there will be inflation thresholds as are observed empirically:

inflation and output are positively (negatively) correlated below (above) the threshold. As a consequence, there is a strict limit to the extent to which domestic inflation can be used to stimulate output. Furthermore, the presence of private information –coupled with relatively high rates of inflation- seems to increase the scope for both instability and economic fluctuations. When the second situation obtains, however, increases in the domestic rate of inflation seem to always have adverse consequences for real activity and private information (together with high rates of inflation) seems always to increase the scope for indeterminacy of dynamic equilibria and for economic fluctuations.

In a small open economy with a fixed rate of exchange, the domestic and foreign inflation rates will be equal. Interestingly again—and, yet in marked contrast to the literature on closed economies- either the scope for credit to be rationed depends in a relatively complicated way on the rate of foreign inflation, or credit rationing tends to be observed when foreign rates of inflation are low. In the first situation, increases in the foreign rate of inflation seem to always have adverse consequences for real activity. In the second situation, however, there will be inflation thresholds: foreign inflation and output are positively (negatively) correlated below (above) the threshold.

Finally, in economies with fixed exchange rates, a currency board seems to increase the scope for economic fluctuations. Such potential for fluctuations disappears as the backing of the domestic money supply and deposits is reduced. Moreover, indeterminacy of dynamic equilibria may be observed independently of the backing of the domestic money supply. And, in economies with fixed exchange rates, the potential

for indeterminacy and fluctuations seems to be positively related to the (world) rate of inflation.

The title of the second chapter of my dissertation is: “Disruptions of Liquidity, International Financial Crises and Monetary Integration.” This paper constitutes an effort to answer the following questions: Can a lack of liquidity in one country, preventing otherwise riskless debt from being repaid at par, affect output and welfare in another country through the operations of international financial markets? And, What are the implications of two countries sharing a common currency for the transmission of financial crises?

In this paper, I analyze a world economy with a financial center and a periphery. The financial center has a larger volume of reserves available to cover for the needs of trade. Such an economy reproduces several aspects of the historical International Gold Standard. The period just mentioned was characterized by frequent crises associated with scarce stocks of currency reserves, plus high short-term interest rates and associated gold flows. These flows seem to affect output in both the financial center and the periphery. The main finding of this paper is that a common currency, combined with no legal restrictions on exchange, helps the financial periphery to overcome liquidity problems and the constraints they imply on output. In addition, in the absence of a common currency, the analysis predicts that the financial center has incentives for restrictive rediscounting while the periphery has motives for developing central banking. However, the questions considered in this paper are of more than just historical interest. They are

also relevant to current issues concerning monetary integration, its costs, and its benefits. These topics are of immediate concern to the members of the European Monetary Union, and to Ecuador and other Latin American countries that are in the process of abandoning national currencies in favor of the dollar.

The title of the third chapter of my dissertation is: “Private Information and Inflation Targeting in Small Open Economies”. An exchange rate regime is defined by a particular choice and financing of monetary targets. Volatility, on the other hand, reflects the presence of endogenous economic fluctuations. This paper attempts to answer the following question: Can different exchange rate regimes have identical steady-state equilibria but, at the same time, have very particular characteristics in terms of stability and vulnerability to volatility?

I model a small open economy that reproduces various aspects of several Latin American economies during the 1990s. Financial intermediaries perform a real allocative function in the presence of multiple reserve requirements and an adverse selection problem in credit markets. The severity of this friction in credit markets is endogenous and, financial intermediaries may need to ration credit in order to induce self-selection. There are no legal restrictions regarding the use of foreign currency or investment abroad.

Under a policy of inflation targeting, steady state equilibria replicate the equilibria under a (free) floating exchange rate regime. Thus, the ability to raise the domestic rate of inflation above the foreign rate of inflation can increase output if credit is rationed.

However, the presence of inflation thresholds determines that there is a strict limit to the extent to which inflation can be used to promote domestic activity.

The scope for economic fluctuations can be typically reduced by a policy of inflation targeting, when compared to either a (free) floating exchange rate regime or a currency board. However, the potential of this policy to improve on stability and/or on determinacy of dynamic equilibria seems to depend strongly on the probability of repaying loans in the economy.

Chapter I

Inflation, Growth and Exchange Rate Regimes in Small Open Economies*

Abstract

What are the relative merits of different exchange rate regimes in small open economies? I investigate this question along the following dimensions: the successful achievement of low and stable rates of inflation, the promotion of financial deepening, and their consequences for the level of real activity.

This paper models two small open economies that reproduce several aspects of the Peruvian and Argentinean economies subsequent to their stabilizations, and that differ only in their choice of exchange rate regime. Financial intermediaries perform a real allocative function in the presence of multiple reserve requirements and obvious credit market frictions that may or may not cause credit to be rationed. There are no legal restrictions regarding the use of foreign currency or investment abroad.

Under floating exchange rates, the ability to raise the domestic rate of inflation above the foreign rate of inflation can increase production if credit is rationed. However,

* I would like to thank Leonardo Auernheimer, Valerie Bencivenga, Dean Corbae, Scott Freeman, Todd Keister, Beatrix Paal, and Maxwell Stinchcombe for very helpful comments and suggestions. I thank very specially Bruce Smith. The paper has also benefited from the discussions in the seminars in CIDE, the Federal Reserve Bank of Atlanta, the Federal Reserve Bank of Kansas City, Indiana University, ITAM, Purdue University, the Second Annual Missouri Economics Conference, Texas A&M University, the University of Missouri and the University of Texas at Austin.

there is a limitation on the extent to which inflation can be used to stimulate production: in the model there exist inflation thresholds. If inflation is increased beyond the threshold level, adverse consequences for real activity will be observed.

Under either fixed or floating exchange rate regimes, the consequences of changes in domestic or foreign inflation can differ dramatically, depending on whether or not credit rationing is observed.

Instability, indeterminacy of dynamic equilibria and economic fluctuations may arise independently of the exchange rate regime. Private information –coupled with high rates of domestic inflation- increases the scope for indeterminacy and for economic fluctuations.

JEL classification: E31, E32, E42, E44, F31, F33, G14, G18, O16

Keywords: Currency Board; Fixed exchange rate regime; Floating exchange rates; Growth; Indeterminacy; Inflation; Multiple Reserve Requirements; Private Information; Stabilization

1 Introduction

One of the most basic issues in monetary economics concerns the relative merits of different methods for achieving stability of the price level. In an open economy context, a consideration of this issue necessarily involves a comparison of fixed versus flexible exchange rate regimes.

Standard quantity theoretic policy prescriptions imply that domestic price level stability can be achieved with a floating exchange rate simply by fixing a low and constant rate of growth for the money supply. However, in countries confronted with high rates of inflation, this is rarely the proposal made for stabilizing the price level. Instead, it is often argued that such economies should fix their rate of exchange against the currency of a country with relatively stable price level -for instance the U.S.¹

Concerns about the stability of the price level loom particularly large in view of two empirical results. First, it is well-established that there is a strong link between the health of an economy's financial system and its long-run real performance². Second, the level of financial development in an economy is very adversely affected by inflation³. These results together suggest that excessively high rates of inflation can have very negative implications for real performance, both in the short and long-run. And, indeed, Bullard and Keating (1995) or Khan and Senhadji (2000) find that, at low initial rates of

¹ Vegh (1995, p.42) for example, argues that “the evidence clearly suggests that, in hyperinflationary situations, price stability can be the immediate result of using the exchange rate as a nominal anchor.”

² See, for instance, King and Levine (1993 a, b), Levine and Zervos (1998), and Levine, Loayza and Beck (2000).

³ See Boyd, Levine and Smith (2001) or Khan, Senhadji, and Smith (2001).

inflation, modest increases in inflation can be associated with higher (long-run) levels of real activity. However, above some threshold, further increases in the rate of inflation seem to have adverse effects on short and long-run activity.

This paper investigates the relative merits of different exchange rate regimes along several dimensions, especially with respect to achieving low and stable rates of inflation, promoting financial deepening, and fostering relatively high levels of long-run real activity.

Issues about alternative exchange rate regimes have taken on particular prominence in a Latin American context, where there are long histories of high rates of inflation. A particular motivation for examining different exchange rate regimes is to think about alternative methods for stabilizing high rates of inflation in a small open economy. Here, I focus my attention on the relative merits of two different policies that have been implemented as part of inflation stabilizations in Latin America and, particularly, in Argentina and Perú.

Perú and Argentina are small open economies that experienced episodes of severe hyperinflation in the late 1980s and early 1990s. Both stabilization programs were successful in reducing inflation rates. In addition, these programs had some common aspects with respect to fiscal policies. However, the main difference, and the one I focus on in this paper, is the choice of exchange rate regime. On the one hand, Argentina implemented a currency board, more consistent with a traditional view of what a stabilization program should be: an exchange rate is fixed to an "anchor currency" and

automatic convertibility is ensured⁴. In Perú, on the other hand, the exchange rate was left to float freely, under the supervision of the Central Bank. The success of the Peruvian stabilization is extremely interesting in view of the commonly accepted point of view that Latin American countries cannot or will not pursue successful stabilizations based on floating exchange rates.

With these facts in mind, I model a small open economy that reproduces several aspects of the Peruvian and Argentinean economies subsequent to their stabilizations. In each economy, financial intermediaries perform a real allocative function in the presence of obvious credit market frictions that may or may not cause credit to be rationed⁵. As shown by Azariadis and Smith (1996) or Boyd and Smith (1997) in a closed economy context, when credit is rationed changes in the rate of inflation can have strong effects on the extent to which credit is rationed, and on financial depth. Here I extend the Azariadis and Smith (1996) framework to the case of a small open economy. In addition, I add several features to the model that are particularly relevant to Latin American experiences. In particular, a domestic and a foreign currency circulate in the domestic economy, and domestic lending is subject to multiple reserve requirements (that are, in general, binding). Finally, there are no legal restrictions either on the use of foreign currency or on investing abroad.

⁴ See Enoch and Gulde (1998).

⁵ Credit rationing is often argued to be a very important aspect of funds allocation in developing economies.

I then consider two such economies that are similar in every respect, except for their choice of exchange rate regime. In the first economy, a floating exchange rate regime will be in place. On the other hand, the second economy will operate under a fixed exchange rate regime, and this economy will be constructed so that a currency board emerges as a special case.

I find that in economies with floating exchange rates, changes in domestic inflation and world (U.S.) inflation affect the domestic capital stock differently according to whether or not credit is rationed. Interestingly -and, in marked contrast to the literature on closed economies⁶- either credit rationing tends to be observed when domestic rates of inflation are low, or else the scope for credit to be rationed depends in a relatively complicated way on the rate of money creation (inflation). The first situation will emerge when the probability of loan default is relatively low while the second will arise when the probability of default is sufficiently high.

In situations where the probability of repaying loans is high and there is a floating exchange rate, moderate increases in the rate of money growth (inflation) stimulate output and lead to financial deepening when credit is rationed (inflation is initially low), but reduce output and financial depth when there is no credit rationing (inflation is initially high). Thus there will be inflation thresholds as are observed empirically: inflation and output are positively (negatively) correlated below (above) the threshold. As a consequence, there is a strict limit to the extent to which domestic inflation can be used

⁶ See, for an example, Azariadis and Smith (1996).

to stimulate output. Furthermore, when equilibrium dynamics are considered, I find that - when credit is rationed- endogenously arising volatility can easily be observed. This volatility will be manifested in all endogenous variables, including the rate of inflation. Thus, in the short-run, a low and fixed rate of money creation need not imply an absence of price level fluctuations, even in the absence of any exogenous shocks.

On the other hand, in situations where the probability of repaying loans is low and there is a floating exchange rate, increases in the domestic inflation rate always have adverse consequences for real activity. Moreover, private information (together with high rates of inflation) seems always to increase the scope for indeterminacy of dynamic equilibria and for economic fluctuations.

In a small open economy with a fixed rate of exchange, the domestic and foreign inflation rates will be equal. Interestingly again -and, yet in marked contrast to the literature on closed economies- either the scope for credit to be rationed depends in a relatively complicated way on the rate of foreign (and domestic) inflation, or credit rationing tends to be observed when foreign (and domestic) rates of inflation are low. Under a fixed exchange rate regime, the first situation will be associated with a low probability of loan default, while the second situation will be observed when the probability of default is high.

In situations where the probability of repaying loans is high and there is a fixed exchange rate, increases in the foreign rate of inflation always have adverse consequences for real activity. In situations where the probability of repaying loans is

low, however, there will be inflation thresholds: foreign (and domestic) inflation and output are positively (negatively) correlated below (above) the threshold.

Of course when the rate of exchange is fixed, the domestic country inherits the inflationary experience of the rest of the world (the U.S.). This is obviously not the case under a flexible exchange rate regime. As the results just described indicate, when credit is rationed the ability to raise the domestic inflation rate above the foreign inflation rate can have positive consequences for financial depth and for real activity, so long as the domestic rate of inflation is not excessively high. In this sense, there can be a real cost to the implementation of a fixed exchange rate regime.

Finally, in economies with fixed exchange rates, a currency board seems to increase the scope for endogenously arising economic fluctuations. Such potential for fluctuations disappears as the backing of the domestic money supply and deposits is reduced. Moreover, indeterminacy of dynamic equilibria may be observed independently of the backing of the domestic money supply. And, in economies with fixed exchange rates, the potential for indeterminacy and fluctuations seems to be positively related to the (world) rate of inflation.

The remainder of the paper is organized as follows. In Section 2, I present a model of a small open economy with floating exchange rates. This economy shares the main stylized characteristics of the Peruvian economy after its stabilization. I then discuss when credit rationing may arise in such an environment as well as the main properties displayed by dynamic equilibria. Next, in Section 3, I consider a model of a small open

economy that operates under a fixed exchange rate regime. I again describe when credit may be rationed and equilibrium dynamics. Finally, in Section 4, I present the main conclusions of the analysis.

2 A Flexible Exchange Rate Regime: the Peruvian Economy after the Stabilization

In this section, I build a model of a small open economy that captures the main stylized characteristics of the post-stabilization Peruvian economy. The model is in the spirit of Azariadis and Smith (1996), who consider a closed economy in which capital investment requires external finance, and in which credit markets operate subject to various informational asymmetries. I extend this framework to the case of a small open economy where both foreign and domestic currencies circulate and where individual agents can invest both at home and abroad. In addition, domestic lending is subject to multiple reserve requirements (that are, in general, binding) and a flexible exchange rate regime is in place, with no legal restrictions on either the use of foreign currency or on foreign investment.

2.1 The Environment

I consider a small open economy consisting of an infinite sequence of two-period lived, overlapping generations. Time is discrete, and indexed by $t=0, 1, 2, \dots$.

Each generation consists of a continuum of agents with unit mass, divided into two types. Type 1 agents comprise a fraction $\lambda \in (0,1)$ of the population, while the remaining fraction $(1 - \lambda)$ consists of Type 2 agents.

Every period, both physical capital and labor are used to produce a single tradable final good. K units of physical capital and N units of labor produce $F(K,N)$ units of the final good, where $F(\cdot)$ is a constant returns to scale production function. Let $f(k) \equiv F(k,1)$ denote the intensive production function, with k being the capital-labor ratio, $k \equiv K/N$. We assume that $f(\cdot)$ is a smooth, increasing, concave function such that $f(0)=0$. Finally, we also assume, without real loss of generality, that physical capital depreciates completely in the production process.

All agents are risk neutral and, for simplicity, care about consumption only in the final period of life.

2.1.1 Endowments

Young Type 1 agents are endowed with one unit of labor, which is supplied inelastically. These agents have no labor endowment when old. In addition, Type 1 agents are endowed with access to two investment technologies. One of these is a pure storage technology whereby one unit of the good stored at t returns $x > 0$ units of consumption at $t+1$. x should be thought of as relatively small, so that the storage technology is not

efficient. The second investment technology available to Type 1 agents transforms one unit of the final good at t into one unit of capital at $t+1$ with probability $\pi \in (0,1)$. With probability $(1-\pi)$, investments in this technology produce nothing. If capital is received when old, a Type 1 agent making an investment can then hire young labor, and produce final goods using the commonly available final goods production technology. For simplicity I assume that this technology can be utilized only by agents who receive capital from previous investments; there are no rental markets in physical capital.

Type 2 agents have no labor endowment when young, but supply one unit of labor inelastically when old. When young, a Type 2 agent is endowed with an investment technology that allows him to transform one unit of the final good at t into one unit of capital at $t+1$ with certainty. Once this capital is obtained, old Type 2 agents can combine their own labor with labor they hire from young Type 1 agents, and they can then produce the final good. Again, purely for simplicity, Type 2 agents are assumed to work only for themselves.

In addition to young agents, there is an initial old generation at $t=0$. These agents are all endowed with one unit of labor and $K_0 > 0$ units of physical capital. No other agents have an initial endowment of capital, nor are any agents endowed with the final good.

2.1.2 Informational Structure

At the beginning of each period, each agent knows his own type. However, the agent's type is private information. Since Type 2 agents are natural borrowers, having access to a productive investment technology but no young period income, this private information gives rise to a conventional adverse selection problem in credit markets.

In addition, if they obtain credit, at some point each young Type 1 agent learns whether or not he can productively invest in physical capital. This information is also private to the agent. However, age and all market transactions (like working, making deposits in or borrowing from the financial system) are observable. The activity of storing goods does not require market transactions, and, therefore, the storage activity is unobservable.

Given the information structure, young Type 2 agents cannot credibly claim to be of Type 1 and supply labor when young. However, young Type 1 agents can credibly claim to be of Type 2. In order to do so, young Type 1 agents must borrow the same amount that young Type 2 agents do and they cannot supply labor. However, only a fraction π of Type 1 agents have the ability to create physical capital. The remaining fraction cannot operate the production process when old and they would then be discovered as having misrepresented their type. We assume that they can be punished prohibitively. Consequently, the fraction $(1-\pi)$ of young Type 1 agents who obtain credit will avoid punishment only if they “abscond” with their loan. They can do so by taking

any credit received when young, investing in the storage technology, and “going underground” when old⁷. The agents both escape punishment, and avoid repaying their loan. Finally, notice that Type 2 agents have no access to the storage technology and, consequently, they choose never to abscond.

2.2 Trading and Financial Intermediation

There are several types of trade that can take place in this economy. First, old producers can hire labor from young Type 1 agents at the competitive real wage, w_t . Second, Type 1 agents who work when young save all their labor income, and part of their savings can be lent to domestic agents claiming to be of Type 2. I will think of domestic lending as being intermediated.

There is free entry into the domestic activity of intermediation. We let R_t denote the gross real interest rate offered on deposits by domestic financial intermediaries between t and $t+1$, and ρ_t the gross interest rate charged on loans made at t and maturing at $t+1$. Third, young Type 1 agents can also invest their savings abroad⁸. One unit of goods invested abroad at t returns $r > 1$ goods at $t+1$, where r is the gross international real

⁷ Alternatively, x can be regarded as representing the punishment incurred after misrepresenting one's type and taking an unproductive loan.

⁸ One could also think of such investments as cross-border deposits. See Baliño, Benner and Borensztein (1999).

interest rate. Of course the assumption that the domestic economy is small implies that no events in the domestic economy influence r . Also notice that the storage technology being inefficient implies that $R_t > x$ and $r > x$.

In addition, two types of currency circulate in the domestic economy. One is issued by the domestic government. Let M_t be the outstanding stock of domestic currency at t and p_t denote the domestic price level. In addition, foreign currency may circulate in the domestic economy. We let Q_t denote the outstanding stock of foreign currency in the domestic country, while p_t^* denotes the price level in the rest of the world. We also let e_t denote the market determined nominal exchange rate at t , defined as units of domestic currency required to purchase a unit of foreign currency at t . The law of one price implies that $e_t p_t^* = p_t$, for all t .

Each initial old agent in the domestic economy is endowed with $M_1 > 0$ units of domestic currency. From then on, the supply of domestic currency evolves according to

$$M_{t+1} = (1 + \sigma)M_t, \quad \sigma > -1 \quad (1)$$

with σ , the net rate of money creation, exogenously determined by the domestic monetary authority. Any injection or withdrawal of domestic currency is done by lump-sum transfers to young agents claiming to be of Type 2. Since capital investment is intended to be done by young Type 2 agents, the transfer scheme can be thought of as a program run by the domestic government intended to subsidize capital investment. This program is financed by printing money. If we let τ_t denote the real value of the transfer

received by a young agent claiming to be of Type 2 at t , and μ_t be the fraction of young Type 1 agents claiming to be of Type 2 at t , the government budget constraint for that period will be

$$[(1-\lambda) + \mu_t \lambda] \tau_t = \frac{(M_t - M_{t-1})}{p_t}, \quad t \geq 0 \quad (2)$$

All domestic lending is subject to the financial regulations of the domestic country. It is assumed that all agents lending domestically must hold currency reserves. Some of these reserves may be held in domestic, and some in foreign currency. Let $\phi_d \in (0,1)$ denote the fraction of deposits that must be held in the form of domestic currency. Domestic currency reserves held from t to $t+1$ earn the gross real return $\left(\frac{p_t}{p_{t+1}} \right)$. Similarly, let $\phi_f \in (0,1)$ denote the fraction of deposits that must be held in the form of foreign currency reserves by lenders. Foreign currency reserves held between t and $t+1$ earn the gross real return $\left(\frac{e_{t+1} p_t}{e_t p_{t+1}} \right)$. Obviously it will be assumed that $\phi_d + \phi_f < 1$. Finally, I will focus on the situation where both reserves requirements are binding. This will transpire if $\left(\frac{p_t}{p_{t+1}} \right) < r$ and $\left(\frac{p_t^*}{p_{t+1}^*} \right) < r$ both hold, so that (net) nominal rates of interest are positive both domestically, and in the rest of the world. Clearly, in contexts like Latin America, the assumption of binding reserve requirements is a highly relevant one.

2.2.1 Credit Markets

In keeping with standard practice in the literature on adverse selection (Rothschild and Stiglitz, 1976; Azariadis and Smith, 1996), I seek a separating equilibrium in credit markets. In particular, I seek an equilibrium where only Type 2 agents obtain credit.

Let b_t denote the real value of borrowing by young agents claiming to be of Type 2 at t ⁹. I assume free entry into intermediation, which implies that domestic intermediaries earn zero profits in equilibrium. This requires that the gross real loan rate, ρ_t , satisfy

$$\rho_t = \frac{\left[R_t - \phi_d \left(\frac{p_t}{p_{t+1}} \right) - \phi_f \left(\frac{e_{t+1} p_t}{e_t p_{t+1}} \right) \right]}{(1 - \phi_d - \phi_f)}. \quad (3)$$

2.3 Agents' Behavior and Factor Markets

Type 2 agents cannot store goods and they do not wish to consume when young. Therefore, they invest in physical capital all the resources they obtain in youth, and each old Type 2 agent at $t+1$ will have a capital stock equal to

$$K_{t+1} = b_t + \tau_t \quad (4)$$

⁹ Young Type 1 agents do not borrow if their Type is known as long as $\rho_t \geq \max\{R_t, r, x\}$. This condition will hold in equilibrium.

reflecting both credit received and the government investment subsidies. In addition, at $t+1$ Type 2 agents combine their inherited capital stock with their own unit of labor, plus L_{t+1} units of young Type 1 labor. Finally, these agents repay their loans. Therefore, the consumption of an old Type 2 agent born at t , $c_{2,t+1}$ is given by

$$c_{2,t+1} = F(K_{t+1}, 1 + L_{t+1}) - w_{t+1}L_{t+1} - \rho_t b_t. \quad (5)$$

Type 2 agents choose L_{t+1} to maximize this expression, implying that

$$w_{t+1} = F_2(K_{t+1}, 1 + L_{t+1}) \quad (6)$$

Combining (5) with (4) and (6), and using Euler's Law, we get that the lifetime utility of a Type 2 agent born at t is

$$c_{2,t+1} = [F_1(K_{t+1}, 1 + L_{t+1}) - \rho_t] b_t + w_{t+1} + F_1(K_{t+1}, 1 + L_{t+1}) \tau_t \quad (7)$$

The first term on the right-hand side of (7) reflects profits (if any) derived from borrowing and investing in physical capital. The second term reflects the value of a Type 2 agent's old labor endowment, and the third term reflects the value of the investment subsidy received from the government.

In a nontrivial separating equilibrium, the total demand for labor at $t+1$ is $(1 - \lambda)L_{t+1}$ while the total supply is λ . Therefore, labor market clearing at $t+1$ requires

$$L_{t+1} = \frac{\lambda}{1 - \lambda} \quad (8)$$

Hence, the capital-labor ratio in such an equilibrium is given by

$$k_{t+1} \equiv \frac{K_{t+1}}{1 + L_{t+1}} = (1 - \lambda)K_{t+1} \quad (9)$$

and (6) can be rewritten as

$$w_{t+1} = f(k_{t+1}) - k_{t+1} f'(k_{t+1}) \equiv w(k_{t+1}) \quad (10)$$

where $w(k_{t+1})$ is an increasing function of k_{t+1} . Notice that equation (10) implies that

$$k_{t+1} = w^{-1}(w_{t+1}) \equiv \Psi(w_{t+1}) \quad (11)$$

so that the maximized consumption of an old Type 2 agent can be written as

$$\begin{aligned} c_{2,t+1} &= \{F_1[\Psi(w_{t+1}), 1] - \rho_t\} b_t + w_{t+1} + F_1[\Psi(w_{t+1}), 1] \tau_t \\ &= \{f'[\Psi(w_{t+1})] - \rho_t\} b_t + w_{t+1} + f'[\Psi(w_{t+1})] \tau_t \end{aligned} \quad (12)$$

Notice that Type 2 agents will be willing to take loans only if

$$f'(\Psi(w_{t+1})) = f'(k_{t+1}) \geq \rho_t \quad (13)$$

2.4 Loan Contracts

In equilibrium, lenders must design loan contracts that channel funds to natural borrowers. Therefore the loan contracts offered, in equilibrium, must prevent Type 1 agents from misrepresenting their type (since it is unprofitable to lend to these agents). Thus loan contracts must induce self-selection¹⁰. I now describe the determination of equilibrium contracts.

¹⁰ In equilibrium, lenders must design loan contracts that channel funds to natural borrowers. Therefore the loan contracts offered, in equilibrium, must prevent Type 1 agents from misrepresenting their type (since it is unprofitable to lend to these agents). Thus loan contracts must induce self-selection.

I begin by describing the incentive constraint that must obtain in order to induce self-selection. A Type 1 agent who misrepresents his type at t borrows b_t , as Type 2 agents do, and receives the investment subsidy τ_t . Subsequent to receiving these resources, the agent learns whether he can produce capital when old. This occurs with probability π . If capital can be produced, the agent will operate the final goods production process when old¹¹. To do so, the agent will hire $\tilde{L}_{t+1}$ units of young labor. In addition, the agent will repay his loan. Thus, with probability π , a dissembling Type 1 agent has the old-age consumption $F(K_{t+1}, \tilde{L}_{t+1}) - \rho_t b_t - w_{t+1} \tilde{L}_{t+1}$. Alternatively, with probability $(1-\pi)$ a dissembling Type 1 agent cannot produce capital. In this event, a Type 1 agent who borrows when young stores the good, and has old-age consumption equal to $x(b_t + \tau_t) = xK_{t+1} = xk_{t+1} / (1 - \lambda)$. It follows that the expected old-age consumption of a young Type 1 agent who misrepresents his type is

$$\tilde{c}_{1,t+1} = \pi [F(K_{t+1}, \tilde{L}_{t+1}) - \rho_t b_t - w_{t+1} \tilde{L}_{t+1}] + (1 - \pi)x(b_t + \tau_t) \quad (14)$$

The agent in question chooses $\tilde{L}_{t+1}$ to maximize this expression¹². Hence

$$F_2(K_{t+1}, \tilde{L}_{t+1}) = w_{t+1} \quad (15)$$

¹¹ It is possible to show that an agent who can operate the production process will prefer to do so, rather than store goods, if the condition $\left[1 - \frac{(1 + \sigma)(1 - \phi_d - \phi_f)}{(1 - \phi_d - \phi_f) + \sigma(1 - \phi_f)}\right] \rho_t \geq x$ is satisfied.

¹² The implicit assumption is that total employment is observable, but the composition of labor inputs between own labor supply and hired youthful labor is not.

This equation implies that a disassembling Type 1 agent who operates the production process will utilize the same capital-labor ratio as a Type 2 agent. It then follows that

$$\tilde{c}_{1,t+1} = \pi \{ [f'[\Psi(w_{t+1})] - \rho_t] b_t + f'[\Psi(w_{t+1})] \tau_t \} + (1 - \pi) x(b_t + \tau_t) \quad (16)$$

Alternatively, a young Type 1 agent who works when young and saves his labor income obtains the lifetime utility $R_t d_t + r i_t^*$, where d_t and i_t^* denote, respectively, deposits in the domestic financial system and investment abroad. Notice that it must be that $d_t + i_t^* = w_t$. It follows that self-selection occurs in the credit market if

$$R_t d_t + r i_t^* \geq \pi \{ [f'[\Psi(w_{t+1})] - \rho_t] b_t + f'[\Psi(w_{t+1})] \tau_t \} + (1 - \pi) x(b_t + \tau_t) \quad (17)$$

It is now easy to verify that competition among lenders implies that contractual loan terms, ρ_t and b_t , must be chosen to maximize the expected utility (consumption) of Type 2 agents, subject to the zero profit condition (3) and the self-selection constraint (17). That is, (b_t, ρ_t) maximizes $c_{2,t+1}$ subject to (3) and (17), taking $\tau_t, w_{t+1}, R_t, p_t, p_{t+1}, p_t^*$ and p_{t+1}^* as given.

As we have already noted, this problem has a nontrivial solution if and only if (13) is satisfied. If (13) is an equality, then Type 2 agents are indifferent about the loan quantity they receive. In equilibrium, loan quantities must simply be such that marginal product of capital equals the loan rate. This outcome is what would be expected in the absence of private information. In effect, the adverse selection problem is non-binding. I refer to this as a Walrasian outcome. Alternatively, if (13) holds as a strict inequality, then Type 2 agents would like to borrow arbitrarily large amounts. Of course, excessive

lending would violate the self-selection constraint. Hence Type 2 agents experience credit rationing, and the loan quantity b_t is determined by the self-selection constraint (17) at equality. Below I describe when both Walrasian and Credit Rationed equilibria emerge as outcomes.

2.5 A General Equilibrium

There are several conditions that must be satisfied in a full general equilibrium. First, in the absence of any restrictions on international goods trade, the purchasing power parity condition

$$p_t = e_t p_t^* \quad (18)$$

must hold. In addition, with no restrictions on international capital flows, rates of return on investments must be equated both internationally and domestically. Hence,

$$R_t = r \quad (19)$$

I assume throughout that $r > x$, so that goods storage is inefficient. In addition, I focus throughout on situations where the reserve requirements bind. Thus

$$r > \frac{p_t}{p_{t+1}} \quad (20)$$

$$r > \frac{p_t^*}{p_{t+1}^*} \quad (21)$$

both hold. Recall that d_t denotes the per capita quantity of deposits held by banks lending domestically. Then, since both reserve requirements bind, it follows that

$$\frac{M_t}{p_t} = \lambda \phi_d d_t \quad (22)$$

and

$$\frac{e_t Q_t}{p_t} = \lambda \phi_f d_t \quad (23)$$

(since a fraction λ of domestic agents are of Type 1, and hence are savers).

Additionally, the market for loans clears if the supply of deposits less bank reserves equals the demand for loans. This condition obtains if

$$(1 - \phi_d - \phi_f) \lambda d_t = (1 - \lambda) b_t \quad (24)$$

Finally, recall that we defined i_t^* to be the real value of net investment abroad, per young Type 1 agent. Then

$$i_t^* = w(k_t) - d_t \quad (25)$$

(that is, net investment abroad equals domestic savings less domestic deposits).

In credit markets, four conditions must be satisfied in equilibrium. First, banks earn zero profits so that (3) holds). Second, (13) must hold. Third, the self-selection constraint (17) must be satisfied. Fourth, an absence of arbitrage opportunities requires that $R_t = r$.

Finally, the government budget constraint -along with the condition that self-selection occurs in the credit market- implies that

$$(1 - \lambda)\tau_t = \left(\frac{\sigma}{1 + \sigma} \right) \frac{M_t}{p_t} \quad (26)$$

2.5.1 Equilibrium Conditions

It is straightforward to show that

$$\frac{p_t}{p_{t+1}} = \frac{k_{t+2}}{(1 + \sigma)k_{t+1}} \quad (27)$$

Next, I define $\varepsilon \equiv \frac{b_t}{K_{t+1}} = 1 - \frac{\tau_t}{K_{t+1}}$. That is, ε denotes the fraction of the capital stock per

producer that is financed with loans from the domestic financial system, as opposed to the fraction financed with the subsidy received from the government. It can be easily shown that

$$\varepsilon = \frac{(1 + \sigma)(1 - \phi_d - \phi_f)}{(1 - \phi_d - \phi_f) + \sigma(1 - \phi_f)} \quad (28)$$

Then, it is possible to write the main equilibrium conditions compactly as

$$f'(k_{t+1}) \geq \rho_t = \frac{\left[r - \left(\frac{\phi_d}{1+\sigma} \right) \left(\frac{k_{t+2}}{k_{t+1}} \right) - \phi_f \left(\frac{p_t^*}{p_{t+1}^*} \right) \right]}{(1-\phi_d - \phi_f)} \quad (29)$$

$$r(1-\lambda)w(k_t) \geq \{\pi[f'(k_{t+1}) - \varepsilon\rho_t] + (1-\pi)x\}k_{t+1} \quad (30)$$

$$i_t^* = w(k_t) - \left(\frac{\varepsilon}{1-\phi_d - \phi_f} \right) \frac{k_{t+1}}{\lambda} \quad (31)$$

Equation (29) asserts that the marginal product of capital must weakly exceed the rate of interest that must be charged on loans in order for Type 2 agents to take loans. Equation (30) is the self-selection condition in loan markets, and equation (31) describes net foreign investment. Note that one of the conditions (29) or (30) must hold as an equality. If (29) is an equality, credit is rationed. Note finally that

$$\sigma > \sigma_\varepsilon \equiv - \left(\frac{1-\phi_d - \phi_f}{1-\phi_f} \right) \quad (32)$$

must hold in order for lending to be positive¹³. (32) is henceforth assumed to hold.

In order to obtain sharp characterizations of equilibria with and without credit rationing, it will henceforth be convenient to assume that the production function has the Cobb-Douglas form $f(k_t) = Ak_t^\alpha; \alpha \in (0,1)$. In addition, I assume that the rest of the world has a constant rate of inflation equal to its constant (net) rate of money creation, σ^* . Thus

¹³ The condition $\sigma > \sigma_\varepsilon$ is needed for $\varepsilon \equiv \frac{b_t}{K_{t+1}} > 0$. In a nontrivial separating equilibrium, $\varepsilon > 0$ implies $b_t > 0$.

$$\frac{p_t^*}{p_{t+1}^*} = \frac{1}{(1 + \sigma^*)} < r \quad (33)$$

Under these assumptions, I next turn to the analysis of steady-states. Dynamic equilibria are taken up in section 2.7.

2.6 Steady-State Equilibria

Steady-state equilibria will be characterized by allocations in which the pair $\{k, i^*\}$ is constant. In addition to (33), the following will be true in any steady state:¹⁴

$$\frac{p_t}{p_{t+1}} = \left(\frac{1}{1 + \sigma} \right) < r \quad (34)$$

$$\rho = \frac{\left[r - \left(\frac{\phi_d}{1 + \sigma} \right) - \left(\frac{\phi_f}{1 + \sigma^*} \right) \right]}{(1 - \phi_d - \phi_f)} \quad (35)$$

I now analyze Walrasian and Credit Rationing regimes separately.

¹⁴ It is easy to show that, if $r > 1$ and $r > \left(\frac{1}{1 + \sigma} \right) \sigma > \text{Max} \left\{ \left(\frac{1}{r} - 1 \right) \sigma_\varepsilon \right\}$ implies that $\rho > 0$ holds. Hence, this is the only condition that need be imposed thus far on the rate of domestic money creation.

2.6.1 Steady-State Equilibria in a Walrasian Regime

A steady-state Walrasian equilibrium has $f'(k) = \rho$, and the self-selection constraint (30) does not bind. Let $\hat{k}$ and $\hat{i}^*$ denote, respectively, the steady-state capital-labor ratio and net investment abroad in a Walrasian regime. (29) allows us to determine $\hat{k}$

$$\hat{k} = \left[\frac{\alpha A}{\rho} \right]^{\frac{1}{1-\alpha}} = \left\{ \frac{\left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]}{\alpha A (1 - \phi_d - \phi_f)} \right\}^{\frac{1}{1-\alpha}} \quad (36)$$

while (31) determines $\hat{i}^*$:

$$\hat{i}^* = (1 - \alpha) A \hat{k}^\alpha - \left(\frac{\varepsilon}{1 - \phi_d - \phi_f} \right) \frac{\hat{k}}{\lambda} \quad (37)$$

An additional variable of interest is the total fraction of savings invested abroad, denoted by $\hat{\chi}$ in a Walrasian steady-state. Clearly, $\hat{\chi}$ is given by the expression

$$\hat{\chi} \equiv \frac{\hat{i}^*}{w(\hat{k})} = 1 - \left[\frac{\varepsilon \hat{k}^{(1-\alpha)}}{\lambda (1 - \alpha) A (1 - \phi_d - \phi_f)} \right] \quad (38)$$

The remainder of this section analyzes the effects of increases in the steady-state rate of domestic inflation (σ), the steady-state rate of inflation in the rest of the world (σ^*), the international interest rate on deposits (r), and the domestic reserve requirements (ϕ_d and ϕ_f). Formal proofs of the propositions stated below can be found in Appendix A.

Proposition 1. *In a Walrasian steady-state, an increase in the rate of domestic inflation (σ) reduces the capital-labor ratio ($\hat{k}$), reversing the Mundell-Tobin effect. In addition, the ratio of investment abroad to total savings in a stationary Walrasian allocation ($\hat{\chi}$) is increasing in the steady-state domestic inflation rate.*

Proposition 2. *An increase in either the steady-state rate of inflation in the rest of the world (σ^*) or the international interest rate on deposits (r) reduces the capital-labor ratio ($\hat{k}$) and increases the ratio of investment abroad to total savings ($\hat{\chi}$) in a Walrasian steady-state equilibrium.*

Proposition 3. *An increase in either the required reserves held in domestic currency (ϕ_d) or the required reserves held in foreign currency (ϕ_f) reduces the capital-labor ratio ($\hat{k}$) in a Walrasian steady-state.*

Intuitively, an increase in either the domestic or the foreign rate of inflation lowers the return a bank receives on its reserves. As a result, the rate of interest on loans must increase in order for domestic banks to compete for deposits in world markets. The higher rate of interest on loans then leads to a reduction in domestic capital investment. Notice that the strength of the effect of higher foreign inflation depends on the magnitude of foreign reserve holdings by domestic lenders. As these reserves become larger, *ceteris paribus*, the consequences of higher foreign inflation become more severe.

Interestingly, higher rates of domestic inflation lead to higher levels of capital outflows. While this is perhaps intuitive, it is also true that higher *foreign* rates of inflation lead to higher levels of capital outflows. This transpires because higher foreign inflation erodes the value of foreign currency reserves as a domestic asset. Domestic investors react by shifting assets abroad in forms whose return is not affected by inflation.

It bears emphasis that some evidence (for instance, Barnes, Boyd and Smith, 1999) strongly suggest that changes in the rate of inflation in the U.S., for example, have had strong consequences for countries like Perú. The analysis of this section indicates how such consequences could arise.

2.6.2 Steady-State Equilibria in a Credit Rationing Regime

A steady-state equilibrium with Credit Rationing has $f'(k) > \rho$. In addition, the self-selection constraint (30) binds. Let $\tilde{k}$ be the steady-state capital-labor ratio in a Credit Rationing regime, and let $\tilde{\chi}$ be the steady-state ratio of investment abroad to savings under the same regime. In this regime, (30) will determine the capital-labor ratio:

$$\tilde{k} = \left\{ \frac{[(1-\pi)x - \pi\epsilon\rho]}{A[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\}^{\frac{1}{(\alpha-1)}} \quad (39)$$

while (31) will determine $\tilde{\chi}$:

$$\tilde{\chi} \equiv \frac{\tilde{i}^*}{w(\tilde{k})} = 1 - \left[\frac{\varepsilon}{\lambda(1-\alpha)A(1-\phi_d - \phi_f)} \right] \tilde{k}^{(1-\alpha)} \quad (40)$$

where $\tilde{i}^*$ denotes investment abroad in a steady-state equilibrium with Credit Rationing.

As before, it is possible to analyze the effects of increases in the domestic rate of inflation, the foreign rate of inflation, and the world real interest rate when credit rationing prevails. The following propositions state some formal results. Once again, proofs of the propositions can be found in Appendix A.

Proposition 4. *Suppose that*

$$r(1-\lambda)(1-\alpha) < (>) \alpha\pi \quad (41)$$

holds¹⁵. Then an increase in the domestic rate of inflation increases (reduces) the steady-state capital-labor ratio $\tilde{k}$. If an increase in the domestic inflation rate reduces $\tilde{k}$, then the same increase necessarily increases the fraction of savings invested abroad ($\tilde{\chi}$).

Proposition 5. *Suppose that $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ holds. Then an increase in the foreign inflation rate (σ^*) or the world real interest rate (r) reduces (increases) the domestic capital-labor ratio $\tilde{k}$. These same changes increase (reduce) the ratio of savings done abroad ($\tilde{\chi}$).*

Proposition 6. *Suppose that $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ holds. Then an increase in the required reserves held in domestic currency (ϕ_d) reduces (increases) the capital-labor*

¹⁵ Of course if $r(1-\lambda)(1-\alpha) > (<) \alpha\pi$, $(1-\pi)x > (<) \varepsilon\rho$ must hold in order for $f'(\tilde{k})$ to be well-defined.

ratio ($\tilde{k}$). On the other hand, an increase in the required reserves held in foreign currency (ϕ_f) reduces (increases) the capital-labor ratio ($\tilde{k}$) if $\sigma > \left\{ \frac{\sigma^* \phi_d}{[r(1 + \sigma^*) - 1]} - 1 \right\}$ but increases (reduces) $\tilde{k}$ if $\sigma < \left\{ \frac{\sigma^* \phi_d}{[r(1 + \sigma^*) - 1]} - 1 \right\}$.

Propositions 4 and 5 illustrate two important points. First, in a Walrasian equilibrium, changes in the domestic rate of inflation and changes in the world rate of inflation have qualitatively similar effects. When credit is rationed, on the other hand, changes in the domestic rate of inflation and the world rate of inflation always affect the domestic capital stock differently. Intuitively, this occurs because credit rationing breaks the link between the marginal product of capital and the rate of interest on loans. What matters when credit is rationed is how the domestic and foreign rate of inflation affect the self-selection constraint (30), and they affect this differently.

Second, changes in the domestic rates of inflation can have very different effects under credit rationing than they do in a Walrasian equilibrium. Again, this happens because what matters is how the domestic rate of inflation affects the self-selection constraint. Higher domestic inflation can actually relax this constraint by increasing the rate of interest on loans, and hence attenuating the incentives of Type 1 agents to misrepresent their type. Whether or not higher rates of domestic inflation have this effect depends on the probability of a Type 1 agent actually repaying a loan if it is taken (that is, it depends on the magnitude of π).

2.6.3 When Does Credit Rationing Occur?

I now describe when credit rationing does and does not arise, in a steady-state equilibrium. As will be clear, whether or not credit rationing is observed depends on things like the domestic and foreign rates of inflation, and on the world real rate of interest.

As has been previously noted, steady-state equilibria do (not) display credit rationing if $f'(k) > (=)\rho$. I therefore turn attention to a description of when $f'(k) > \rho$ holds.

To do so, the following result will prove useful. The proofs of lemmas and propositions can be found in the Appendix.

Lemma 7. *The steady-state interest rate on loans is a monotonically increasing and concave function of the steady-state domestic inflation rate, for any*

$\sigma > \text{Max}\left\{\left(\frac{1}{r} - 1\right), \sigma_\varepsilon\right\}$, and it is bounded above.

If $\rho(\sigma)$ denotes the loan rate as a function of σ , then lemma 7 implies that $\rho(\sigma)$ has the configuration depicted in Figures 1 and 2.

When credit rationing can emerge now depends on assumptions on parameter values. I describe two cases.

Case 1: $\alpha\pi > r(1-\lambda)(1-\alpha)$. When Case 1 obtains, $f'(\tilde{k})$ is a monotonically decreasing function of σ . Moreover, as $\varepsilon\rho$ grows smaller and closer to $\left(\frac{1-\pi}{\pi}\right)_x$, $f'(\tilde{k})$ decreases and, typically, converges to a small and positive number. Thus we have the situation depicted in Figure 1. Credit is rationed iff $\sigma < \sigma_c$ holds.

When Case 1 obtains, if the initial domestic rate of inflation is fairly low, increases in the domestic rate of inflation (that is, increases in σ) can be used to stimulate capital formation and long-run output¹⁶. However, there is a strict limit to the extent to which domestic inflation can be used for this purpose. Once $\sigma > \sigma_c$, the equilibrium will be Walrasian, and further increases in the domestic money growth rate will have adverse consequences for long-run real activity¹⁷. Thus there will be inflation thresholds, as is observed empirically.

Case 2: $\alpha\pi < r(1-\lambda)(1-\alpha)$. In a Case 2 economy, $f'(\tilde{k})$ can be shown to be an increasing, concave function of σ . As a result, several possibilities arise regarding the existence of steady states where credit is rationed. The possibilities are illustrated by Figures 2a, 2b and 2c.

¹⁶ This is consistent with evidence reported by Bullard and Keating (1995) and Khan and Senhadji (2000) that, at low rates of inflation, moderate increases in the rate of inflation can increase the long-run level of real activity.

¹⁷ This is consistent with evidence that, at high enough rates of inflation, further increases in inflation have detrimental effects on the level of long-run activity. Again, see Bullard and Keating (1995) or Khan and Senhadji (2000).

Figure 2a. For high (low) values of the domestic inflation rate, credit is (is not) rationed. This situation tends to transpire when x is relative large.

Figure 2b. For rates of money creation below σ_L or for rates of money creation above σ_H , credit is not rationed. Credit is rationed only if $\sigma \in (\sigma_L, \sigma_H)$.

Figure 2c. $\rho(\sigma)$ lies everywhere above $f'(\tilde{k})$. This situation tends to arise when x is relatively small.

Notice that, in a Case 2 economy, the scope for credit to be rationed may depend in a relatively complicated way on the rate of money creation (inflation). In particular, the “bindingness” of informational asymmetries need not depend monotonically on the rate of inflation.

2.7 Dynamic Equilibria

2.7.1 Dynamic System in a Walrasian Regime

The dynamic system in a Walrasian regime is given by:

$$(1 - \phi_d - \phi_f)\alpha A k_{t+1}^{\alpha-1} = \left[r - \left(\frac{\phi_f}{1 + \sigma^*} \right) \right] - \left(\frac{\phi_d}{1 + \sigma} \right) \left(\frac{k_{t+2}}{k_{t+1}} \right) \quad (42)$$

$$i_t^* = (1 - \alpha) A k_t^\alpha - \left[\frac{\varepsilon}{\lambda(1 - \phi_d - \phi_f)} \right] k_{t+1} \quad (43)$$

$$r(1 - \lambda)(1 - \alpha) A k_t^\alpha > [\pi(1 - \varepsilon)\alpha A k_{t+1}^{\alpha-1} + (1 - \pi)x] k_{t+1} \quad (44)$$

Notice that (42) and (43) constitute a recursive dynamic system: equation (42) completely governs the dynamics of the per capita capital stock. Equation (43) then indicates how cross-border capital flows inherit their dynamics from the dynamics of the capital-labor ratio.

Lagging (42) one period and rearranging terms for the per capita stock yields

$$k_{t+1} = \left(\frac{1+\sigma}{\phi_d} \right) \left\{ \left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right] k_t - (1-\phi_d-\phi_f)\alpha A k_t^\alpha \right\} \quad (45)$$

Figure 3 depicts equation (45). Evidently, the only non-trivial equilibrium is the steady state. The economy can attain the steady-state after one period by borrowing or lending abroad.

2.7.2 Dynamic System in a Credit Rationing Regime

When credit is rationed, equation (30) governs the dynamics of the capital stock, and equation (29) holds as a strict inequality. Given the assumption of Cobb-Douglas production, equation (30) can be represented by the following dynamic system:

$$r(1-\lambda)(1-\alpha)Ay_t^\alpha = (1-\pi)xk_t + \pi\alpha A k_t^\alpha - \left(\frac{\pi\mathcal{E}}{1-\phi_d-\phi_f} \right) \left[r - \left(\frac{\phi_d}{1+\sigma} \right) \frac{k_{t+1}}{k_t} - \left(\frac{\phi_f}{1+\sigma^*} \right) \right] k_t \quad (46)$$

$$y_{t+1} = k_t \quad (47)$$

The phase diagram for the dynamic system is depicted in Figure 4.

Local Stability. I now linearize the dynamic system (46) and (47) in a neighborhood of the nontrivial steady state. The Jacobian of the linearized system is

$$J(\tilde{k}, \tilde{y}) = \begin{bmatrix} J_{11} & J_{12} \\ 1 & 0 \end{bmatrix},$$

where

$$J_{11} \equiv \frac{\partial k_{t+1}}{\partial k_t} \bigg|_{(\tilde{k}, \tilde{y})} = -E\alpha f'(\tilde{k}) + \left(\frac{1+\sigma}{\phi_d} \right) \left(r - \frac{\phi_f}{1+\sigma^*} \right) - E \left(\frac{1-\pi}{\pi} \right) \quad (48)$$

$$J_{12} \equiv \frac{\partial k_{t+1}}{\partial y_t} \bigg|_{(\tilde{k}, \tilde{y})} = E \left[\frac{r(1-\lambda)(1-\alpha)}{\pi} \right] f'(\tilde{k}) \quad (49)$$

and where

$$E \equiv \left[\frac{(1-\phi_d - \phi_f) + \sigma(1-\phi_f)}{\phi_d} \right] \quad (50)$$

Let T and D denote, respectively, the trace and the determinant of the Jacobian. Notice that $D < 0$ for all values of σ associated with a positive marginal product of capital. As a result, both eigenvalues will be real and distinct, and they will have opposite signs. Moreover, it can be shown that

$$1 - T + D = \frac{(1-\alpha)Ef'(\tilde{k})}{\alpha\pi} [r(1-\lambda)(1-\alpha) - \alpha\pi] \quad (51)$$

and,

$$1 + T + D = 2 + Ef'(\tilde{k})(1-\alpha) \left[\frac{\alpha\pi - r(1-\lambda)(1+\alpha)}{\alpha\pi} \right] \quad (52)$$

Therefore, the dynamics in a neighborhood of the nontrivial steady-state will change dramatically depending on whether Case 1 or Case 2 applies. In what follows I describe some formal results. It will be useful to notice that $E > 0$, $\forall \sigma > \text{Max}\left\{\left(\frac{1}{r} - 1\right)\sigma_\varepsilon\right\}$, and that $Ef'(\tilde{k})$ is always increasing in σ .

Case 1: $\alpha\pi > r(1 - \lambda)(1 - \alpha)$. In a Case 1 Economy, $1 - T + D < 0$, $\forall \sigma > \text{Max}\left\{\left(\frac{1}{r} - 1\right)\sigma_\varepsilon\right\}$. However, it is possible for $[\alpha\pi - r(1 - \lambda)(1 + \alpha)]$ to be either positive or negative, and therefore, the properties of $1 + T + D$ will change accordingly.

Case 1.1. When $[\alpha\pi - r(1 - \lambda)(1 + \alpha)] > 0$ obtains, $1 + T + D > 0 > 1 - T + D$, $\forall \sigma$. The steady state is a saddle with a negative stable eigenvalue. Therefore, dynamic equilibria are determinate and damped oscillations will be observed along the stable manifold.

Case 1.2. When $[\alpha\pi - r(1 - \lambda)(1 + \alpha)] < 0$ obtains, $1 + T + D$ is monotonically decreasing in σ . Hence, it is possible that $1 + T + D > 0$ holds for low values of σ whereas $1 + T + D < 0$ holds as σ increases. Or it is possible that $1 + T + D < 0$ holds for all the values of σ within the range considered. In what follows, we consider both possibilities.

a) $1 + T + D > (<) 0$ for low (high) values of σ . This situation transpires when x is relatively large.

a.1) For low values of σ , $1+T+D>0>1-T+D$. The steady state is a saddle with a negative stable eigenvalue, and dynamic equilibria are determinate. Again, damped oscillations will be observed along the stable manifold.

a.2) For high values of σ , $1+T+D<0$. The steady state is a source. Moreover, oscillations may be observed if σ is high enough.

b) $1+T+D<0$, $\forall \sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right)\sigma_\varepsilon\right\}$. This situation transpires when x is relatively small, and the steady state is always a source. Again, oscillations may be observed for high enough values of σ .

Case 2: $\alpha\pi < r(1-\lambda)(1-\alpha)$. In a Case 2 Economy, $1-T+D>0$, $\forall \sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right)\sigma_\varepsilon\right\}$. However, as observed before, it is possible that either $1+T+D>(<)0$ for low (high) values of σ . Alternatively, $1+T+D<0$ could hold for all the values of σ within the range considered (when x is relatively large).

Whenever $1+T+D$ changes sign from positive to negative as σ increases, it is possible to observe the following:

a) For low values of σ , $1+T+D>1-T+D>0$ and $|D|<1$. The steady state is a sink and dynamic paths approach the steady state monotonically. Dynamic equilibria are indeterminate.

b) As the domestic rate of money creation increases, $0 < 1+T+D < 1-T+D$ and $|D| < 1$. The steady state is again a sink, but dynamic paths approaching the steady-state exhibit damped oscillations. Hence, dynamic equilibria are indeterminate and display cyclical fluctuations.

c) For high values of σ , $1-T+D > 0$ and $1+T+D < 0$. The steady state becomes a saddle with a positive stable eigenvalue. Equilibria are, then, determinate, and no fluctuations will be observed along the stable manifold.

On the other hand, whenever $1+T+D < 0 < 1-T+D$, $\forall \sigma > \text{Max} \left\{ \left(\frac{1}{r} - 1 \right) \sigma_\varepsilon \right\}$, the steady state is always a saddle with a positive stable eigenvalue.

Some Consequences of Equilibrium Dynamics. When perfect foresight dynamics allow for oscillations -as can be the case when credit is rationed- then there will be endogenously arising volatility in output, the price level, and net investment abroad. In particular, along dynamic equilibrium paths, all of these variables will fluctuate, even in the absence of exogenous shocks. Thus, when credit is rationed, a policy of floating exchange rates coupled with a constant rate of money creation need not imply the short-run existence of a relatively stable rate of inflation. In addition, the presence of credit rationing and the possibility of associated endogenous volatility can help to explain why net foreign investment tends to be very volatile relative to observed changes in obvious exogenous variables.

3 A Fixed Exchange Rate Regime: Argentina After the Stabilization

In this section, I consider an economy that operates under a fixed rather than a flexible exchange rate regime. This exchange rate regime will be constructed so that a currency board emerges as a special case. Obviously, the intention is to model an economy with a credit market friction that -in certain respects- resembles Argentina subsequent to its stabilization. Of course in all respects except for the exchange rate regime that is in place, the economy remains as described in the previous sections.

3.1 Government Policy

I consider a regime where, in the initial period, the government sets once and for all the nominal exchange rate e . In addition, the domestic monetary authority may hold foreign currency reserves. These reserves may constitute some fraction of the domestic monetary base, or they may even include some fraction of domestic deposits. There is, of course, some issue as to how these reserves are held: they may be held either in the form of (non-interest bearing) foreign currency, or in the form of interest-bearing foreign assets. To fix ideas, I assume that all reserves are held in the form of safe, interest-bearing foreign

assets (bonds). But the analysis would be altered in only minor ways if reserves were held in the form of foreign currency.

Let B_t^* denote the foreign bonds held as reserves by the domestic monetary authority. Then,

$$B_t^* = \left(\frac{\theta}{e} \right) M_t + \xi p_t^* \lambda d_t \quad (53)$$

Here $\theta \in (0,1)$ gives the foreign “currency” reserves that are held against the domestic money supply, measured in units of foreign currency $\left(\frac{M_t}{e} \right)$, and $\xi \in (0,1)$ gives the reserves that the domestic monetary authority holds against domestic bank deposits. In what follows, to fix ideas and without real loss of generality, I use the normalization $e=1$ ¹⁸. A situation where $\theta=\xi=0$ defines what I call a *pure exchange rate regime*, in the sense that the government fixes the exchange rate without any backing of either the domestic money supply or domestic deposits¹⁹. On the other hand, situations where $\theta=1$ and $\xi \geq 0$ define a *currency board*: the domestic money supply is backed 100% and there may be some backing of domestic deposits too²⁰.

When the domestic monetary authority holds reserves, it is necessary to modify the government budget constraint. In particular, that constraint now takes the form

¹⁸ In the absence of the normalization, θ would simply be replaced by $\left(\frac{\theta}{e} \right)$ whenever it appears.

¹⁹ The exchange rate is maintained by injecting or withdrawing money, as required, through the investment subsidy program.

²⁰ For technical reasons that will become clearer I assume that $\xi < (1 - \theta\phi_d - \phi_f)$.

$$(1 - \lambda)\tau_t = \frac{(M_t - M_{t-1})}{p_t} - \frac{\left[B_t^* - r \left(\frac{p_t^*}{p_{t-1}^*} \right) B_{t-1}^* \right]}{p_t^*} \quad (54)$$

This constraint asserts that the value of seigniorage revenue less the change in the central bank's reserve position is used to finance an investment subsidy to agents claiming to be of Type 2. Obviously, (54) incorporates the fact that self-selection does occur in a non-trivial equilibrium.

Next observe that, since the nominal rate of exchange is constant,

$$\frac{p_t}{p_{t+1}} = \frac{p_t^*}{p_{t+1}^*}, \forall t \quad (55)$$

Therefore, the interest rate on loans maturing at $t+1$ must equal

$$\rho_t = \frac{\left[r - (\phi_d + \phi_f) \left(\frac{p_t^*}{p_{t+1}^*} \right) \right]}{(1 - \phi_d - \phi_f)} \quad (56)$$

The remaining conditions of equilibrium are not altered by the change in exchange rate regime. Thus, the conditions of non-trivial separating equilibria are as follows:

$$rw(k_t) \geq \{ \pi [f'(k_{t+1}) - \rho_t] + (1 - \pi)x \} \frac{k_{t+1}}{(1 - \lambda)} + \pi \rho_t \tau_t \quad (57)$$

$$f'(k_{t+1}) \geq \rho_t = \frac{\left[r - (\phi_d + \phi_f) \left(\frac{p_t^*}{p_{t+1}^*} \right) \right]}{(1 - \phi_d - \phi_f)} \quad (58)$$

$$\tau_t = \left(\frac{G_1}{1-\lambda} \right) k_{t+1} + \left(\frac{G_2}{1-\lambda} \right) k_t - G_2 \tau_{t-1} \quad (59)$$

$$i_t^* = w(k_t) + \frac{[(1-\lambda)\tau_t - k_{t+1}]}{\lambda(1-\phi_d - \phi_f)} \quad (60)$$

where:

$$G_1 \equiv \left[\frac{(1-\theta)\phi_d - \xi}{1-\theta\phi_d - \phi_f - \xi} \right] \text{ and } G_2 \equiv \frac{(1+\sigma^*)r(\theta\phi_d + \xi) - \phi_d}{(1-\theta\phi_d - \phi_f - \xi)(1+\sigma^*)} \quad (61)$$

Equation (57) is the self-selection constraint: it holds with equality if credit is rationed. Equation (58) holds with equality in a Walrasian equilibrium. Equation (60), which describes net investment abroad, and equation (59), which is the government budget constraint, hold both in credit rationing and Walrasian equilibria.

I begin by discussing stationary equilibria in which credit is and is not rationed.

3.2 Stationary Equilibria

In a steady state, k_t , i_t^* and τ_t are constant. I begin with a description of Walrasian equilibria.

3.2.1 Steady-State Equilibria in a Walrasian Regime

A Walrasian steady-state equilibrium is such that $f'(k)=\rho$ and the self-selection constraint (57) does not bind. Let $\hat{k}, \hat{i}^*$ and $\hat{\tau}$ denote, respectively, the steady-state capital-labor ratio, net investment abroad and the transfer to producers in a Walrasian regime. We also define $\hat{\chi}$ to be the ratio of investment abroad to total savings in this regime. From (58) we are able to determine that^{21,22}

$$\hat{k} = \left[\frac{\alpha A}{\rho} \right]^{\frac{1}{1-\alpha}} = \left\{ \frac{\left[r - \left(\frac{\phi_d + \phi_f}{1 + \sigma^*} \right) \right]^{\frac{1}{\alpha-1}}}{\alpha A (1 - \phi_d - \phi_f)} \right\} \quad (62)$$

(59) and (60), respectively, then give $\hat{\tau}$ and $\hat{\chi}$ as a function of $\hat{k}$:

$$\hat{\tau} = \delta \frac{\hat{k}}{(1 - \lambda)} \quad (63)$$

$$\hat{\chi} = 1 + \frac{(\delta - 1)\hat{k}^{1-\alpha}}{\lambda(1 - \phi_d - \phi_f)(1 - \alpha)A} \quad (64)$$

where δ , the subsidy rate on the capital stock per old producer, is defined as

$$\delta \equiv \frac{(1 + \sigma^*)(r - 1)(\theta\phi_d + \xi) + \sigma^*\phi_d}{(1 + \sigma^*)(r - 1)(\theta\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f)} \quad (65)$$

Note that

²¹ Note that, henceforth, we still use a Cobb- Douglas characterization of the production technology.

²² Note that, in order for $\hat{k}$ to be well-defined, $\sigma^* > \sigma_\rho^* \equiv \frac{\phi_d + \phi_f}{r} - 1$ must hold.

$$\sigma^* > \text{Max} \left\{ \sigma_\delta^*, \left(\frac{1}{r} - 1 \right) \right\}, \quad \sigma_\delta^* \equiv - \frac{[(r-1)(\theta\phi_d + \xi) + (1-\phi_d - \phi_f)]}{[(r-1)(\theta\phi_d + \xi) + (1-\phi_f)]} \quad (66)$$

must hold for lending to be positive and for the domestic reserve requirements to bind. (66) is henceforth assume to hold.

Notice that the steady-state level of the capital-labor ratio in a Walrasian regime is unaffected by the choice of θ and/or ξ , i.e., by how the domestic money supply is “backed” in a fixed exchange rate regime. However, increases in either θ or ξ increase δ and therefore, affect the capital subsidy ($\hat{\tau}$) and the share of net investment abroad in total savings ($\hat{\chi}$).

It is also worth noticing that increases in either σ^* (which happens to be both the foreign and domestic steady-state inflation rate), r , or the domestic reserve requirements (ϕ_d or ϕ_f) reduce the steady-state capital-labor ratio, independently of whether a currency board regime or a pure fixed exchange rate regime is in place. Of course, this result transpires from the direct link between the marginal product of capital and the rate of interest on loans that exists when credit is not rationed. This link does not depend on the “backing” of the domestic money supply in a fixed exchange rate regime (i.e., the choice of θ or ξ). In addition, higher inflation abroad always increases both the subsidy rate δ ²³ and the share of net investment abroad in total savings ($\hat{\chi}$).

²³ This is a result of the increase in domestic seigniorage income associated with a higher value of the money growth rate.

Comparative Statics under a Currency Board. The main component of a currency board regime, in an environment like the one described in this section, is the choice to set the policy parameter $\theta=1$. ξ could be chosen by the monetary authority such that $0 \leq \xi < (1 - \phi_d - \phi_f)$. Any choice of ξ within this range makes no difference, qualitatively, in terms of the results that I discuss in this section of the paper.

In a currency board regime, an increase in the world real interest rate r obviously increases the real return on the central bank's reserve position, and therefore, it increases the subsidy rate on capital (δ). On the other hand, the same increase in r also increases $\hat{\chi}$, through the resulting increase in δ and reduction in $\hat{k}$. Obviously, this effect operates until the rate of return on domestic deposits equals the new level of r .

Finally, increases in either of the domestic reserve requirements (i.e., either ϕ_d or ϕ_f) always increase δ and $\hat{\chi}$ when a currency board is in place.

Comparative Statics under a Pure Fixed Exchange Rate. In a pure fixed exchange rate regime, both θ and ξ are set equal to zero by the monetary authority, and the central bank does not hold any reserves for backing either the domestic money supply or domestic deposits. This regime is qualitatively different than a currency board in the following sense: increases in r under this regime have no direct effect on the government's finances, leaving δ unaffected. However, for the same reasons as before, increases in r lead to a higher share of investment abroad in total savings, and this effect operates until the rate of return on domestic deposits equals the new level of r .

Finally, increases in either of the domestic reserve requirements (ϕ_d or ϕ_f) will increase (decrease) δ when the foreign rate of inflation is positive (negative). As a result, $\hat{\chi}$ will be increasing in either ϕ_d or ϕ_f for all values but very small values of σ^* .

3.2.2 Steady-State Equilibria in a Credit Rationing Regime

Steady-state equilibria under a Credit Rationing regime have $f'(k) > \rho$, and the self-selection constraint (57) binds. Let $\tilde{k}$, $\tilde{i}^*$ and $\tilde{\tau}$ denote, respectively, the steady-state capital-labor ratio, investment abroad and transfer to producers in a Credit Rationing regime. As we did before, we also define $\tilde{\chi}$ to be the ratio of investment abroad to total savings in this regime. From (59), we can express $\tilde{\tau}$ as a function of the capital-labor ratio

$$\tilde{\tau} = \delta \frac{\tilde{k}}{(1-\lambda)}, \quad (67)$$

where δ has been defined in (65). Using this information, we can determine the steady-state capital stock from (57),

$$\tilde{k} = \left\{ \frac{[(1-\pi)x - \pi(1-\delta)\rho]}{A[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\}^{\frac{1}{\alpha-1}} \quad (68)$$

and $\tilde{\chi}$ from (60)

$$\tilde{\chi} = 1 + \frac{(\delta - 1)\tilde{k}^{1-\alpha}}{A\lambda(1 - \phi_d - \phi_f)(1 - \alpha)}. \quad (69)$$

In contrast with what we observed in stationary equilibria under a Walrasian regime, the steady-state capital-labor ratio in a Credit Rationing equilibrium is affected by the choice of θ and/or ξ made by the monetary authority. Increasing either θ or ξ has a direct positive effect on the government's finances, increasing the subsidy rate on capital, δ . As this subsidy rate changes, it alters the incentives of Type 1 agents to misrepresent their type. In order to induce self-selection, there must be a corresponding change in the degree of credit rationing. Of course, as was true previously, the effects of changes in δ may vary depending on different assumptions on parameter values. I now investigate the effects of increases in the world inflation rate (σ^*), the world interest rate on deposits (r), the domestic reserve requirements (ϕ_d and ϕ_f), and the parameters θ and ξ .

Case 1: $\alpha\pi > r(1 - \lambda)(1 - \alpha)$. When Case 1 obtains, an increment in δ due to an increase in either θ or ξ , ceteris paribus, increases the subsidy received by agents claiming to be of Type 2 and, in this way, affects the self-selection constraint. Given the high probability of repaying loans (π), $\tilde{k}$ has to adjust upward to maintain the incentives of agents to self-select. As a consequence, the transfer to capital producers ($\tilde{\tau}$) increases and the share of net investment abroad in total savings ($\tilde{\chi}$) falls.

Comparative Statics under a Currency Board. When Case 1 obtains, and when a currency board is in place, an increase in the (domestic and) foreign inflation rate σ^*

has some potentially complicated consequences. These are described in the following proposition.

Proposition 8. Let $\xi_c \equiv \left(\frac{\phi_d}{\phi_d + \phi_f} \right) (1 - \phi_d - \phi_f)$, and let Case 1 obtain.

a) When $\xi \in [0, \xi_c)$, an increase in σ^* causes $\tilde{k}$ to fall and $\tilde{\chi}$ to increase if

$$r < r_c \equiv \frac{(\phi_d + \phi_f)(1 - \theta\phi_d - \phi_f - \xi)}{[\phi_d - (\phi_d + \phi_f)(\theta\phi_d + \xi)]} \quad (70)$$

holds²⁴.

b) When $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$, then an increase in σ^* causes $\tilde{k}$ to fall, whether $r < r_c$ holds or not. On the other hand, when $r < r_c$, $\tilde{\chi}$ will be increasing (decreasing) in σ^*

if $x < (>) \left(\frac{\pi}{1 - \pi} \right) \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$ holds²⁵.

Intuitively, under the conditions described, an increase in σ^* increases the net of subsidy effective real interest rate on loans, $(1 - \delta)\rho$. This, in turn, affects the incentives of Type 1 agents to misrepresent their type. Given that $\alpha\pi > r(1 - \lambda)(1 - \alpha)$, the capital stock must fall in order to maintain the incentives of agents to self-select.

²⁴ Note that $r_c < \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$ holds. However, for parameter values that seem to obtain in a Latin American context, r_c is fairly large. Thus, this condition is likely to be satisfied in practice.

²⁵ Note that when $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$ holds, $r_c \geq \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$ holds.

With respect to changes in the world interest rate, increments in r in a currency board regime increase the real return on the central bank's reserves, thereby increasing the effective capital subsidy, δ . However, changes in r also affect the self-selection constraint and, under the present configuration of parameters, $\tilde{k}$ must fall. Finally, the share of net investment abroad increases as a result of the higher r .

Under a fixed exchange rate regime, the only instruments of domestic monetary policy are the reserve requirements ϕ_d and ϕ_f . An increase in ϕ_f reduces the capital stock ($\tilde{k}$) when Case 1 obtains and a currency board regime is in operation, but an increase in ϕ_d seems to have an ambiguous effect on $\tilde{k}$. Changes in both ϕ_f and ϕ_d have ambiguous effects on the fraction of wealth allocated to foreign assets, $\tilde{\chi}$.

Comparative Statics under a Pure Fixed Exchange Rate. Given that $\alpha\pi > r(1-\lambda)(1-\alpha)$, and if $r < r_c$ holds, in a pure fixed exchange rate regime an increase in σ^* must cause $\tilde{k}$ to fall in order to maintain the incentives of agents to self-select. The share of net investment abroad in total savings is always increasing in the rate of foreign (and domestic) inflation.

Increases in the world interest rate r do not affect the subsidy rate δ when the domestic money supply is not backed. However, they do affect the interest rate on loans, and deposits, thereby affecting the self-selection constraint. As a result, $\tilde{k}$ must fall to

maintain the incentives of Type 1 agents to self-select. At the same time, when the world rate of interest rises, so does the share of net investment abroad in total savings ($\tilde{\chi}$).

Finally, increases in either of the domestic reserve requirements (ϕ_d or ϕ_f) in general reduce the creation of physical capital ($\tilde{k}$).

Case 2: $\alpha\pi < r(1-\lambda)(1-\alpha)$. When Case 2 obtains, increases in σ^* , r , or the domestic reserve requirements (ϕ_d or ϕ_f) will have the opposite effects on physical capital ($\tilde{k}$) than would be observed when Case 1 obtains.

Comparative Statics under a Currency Board. When Case 2 obtains and a currency board is in place, increases in the world interest rate (r) or in the domestic reserve requirements (ϕ_d or ϕ_f) will have ambiguous effects on $\tilde{\chi}$. On the other hand, higher foreign rates of inflation (σ^*) will affect $\tilde{\chi}$ as stated in the following proposition.

Proposition 9. *When Case 2 obtains and $\xi \in [0, \xi_c)$, the share of net investment abroad*

in total savings ($\tilde{\chi}$) is decreasing (increasing) in σ^* when $x < (>) \left(\frac{\pi}{1-\pi} \right) \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$. On

the other hand, if $\xi \in [\xi_c, (1-\phi_d - \phi_f))$, $\tilde{\chi}$ is always increasing in σ^* .

Comparative Statics under a Pure Fixed Exchange Rate. When Case 2 obtains and a pure fixed exchange rate regime is in place, increases in the world interest rate (r) or in the domestic reserve requirements (ϕ_d or ϕ_f) will always increase the share of net

investment abroad in total savings ($\tilde{\chi}$). On the other hand, $\tilde{\chi}$ will be decreasing

(increasing) in σ^* when $x < (>) \left(\frac{\pi}{1-\pi} \right) \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$.

3.2.3 When Does Credit Rationing Occur?

In this section, I describe when credit rationing does and does not arise, in a steady-state equilibrium. Whether or not credit rationing is observed depends on things like the foreign rate of inflation, σ^* (which is equal to the domestic rate of inflation), the world interest rate (r), and the structure of reserve requirements in the economy. As has been noted in previous sections, steady-state equilibria do (not) display credit rationing if $f'(\tilde{k}) > (=)\rho$. This condition is equivalent to

$$\alpha[(1-\pi)x - \pi(1-\delta)\rho] < (>)[r(1-\lambda)(1-\alpha) - \alpha\pi]\rho \quad (71)$$

whenever $\alpha\pi > (<)r(1-\lambda)(1-\alpha)$. In order to state when (71) holds, the following results will prove useful.

Lemma 10. *The steady-state interest rate on loans is a monotonically increasing and concave function of the steady-state inflation rate in the rest of the world, for any*

$\sigma^* > \text{Max} \left\{ \sigma_\delta^*, \left(\frac{1}{r} - 1 \right) \right\}$, *and it is bounded above. These properties do not depend upon*

how the domestic money supply is backed in a fixed exchange rate regime.

Lemma 11. *If $r < r_c$, then $(1 - \delta)\rho$ is an increasing function of the steady-state inflation rate in the rest of the world, for any $\sigma^* > \text{Max}\left\{\sigma_\delta^*, \left(\frac{1}{r} - 1\right)\right\}$. This property does not depend upon how the domestic money supply is backed in a fixed exchange rate regime.*

If $\rho(\sigma^*)$ denotes the interest rate on loans as a function of the inflation rate in the rest of the world, then Lemma 10 implies that $\rho(\sigma^*)$ has the configuration depicted in Figures 5 and 6. When credit rationing can emerge now depends, for given levels of foreign steady-state inflation, on assumptions on parameter values and on the nature of the fixed exchange rate regime in place.

Case 1: $\alpha\pi > r(1 - \lambda)(1 - \alpha)$. In situations where Case 1 obtains, both the left and the right hand side of (71) are not only negative but also decreasing in the foreign rate of inflation, σ^* . As stated previously, these properties do not depend upon how the domestic money supply is backed in a fixed exchange rate regime. As a result, the scope for credit to be rationed may depend in a relatively complicated way on the rate of foreign inflation. Two of these possibilities are illustrated in Figures 5a, and 5b.

Figure 5a. For low (high) levels of the foreign inflation rate, credit is (is not) rationed. This situation tends to transpire in a Case 1 economy when x is relatively large.

Figure 5b. $f'(\tilde{k})$ lies everywhere above $\rho(\sigma^*)$. This situation tends to transpire in a Case 1 economy when x is relatively small.

Thus, in economies where Case 1 obtains and a fixed exchange rate regime is in place, the scope for credit to be rationed depends in a relatively complicated way on the rate of foreign inflation. In such a situation, increases in the level of steady-state foreign inflation are always detrimental to long-run output. There is no range of inflation rates over which increases in inflation promote real activity.

Case 2: $\alpha\pi < r(1-\lambda)(1-\alpha)$. In situations where Case 2 obtains (71) can be rewritten as

$$\alpha[(1-\pi)x - \pi(1-\delta)\rho] > [r(1-\lambda)(1-\alpha) - \alpha\pi]\rho. \quad (72)$$

Notice that the left-hand side of (72) is positive and decreasing in σ^* , while the right-hand side is also positive but increasing in σ^* . Again, these properties do not depend upon how the domestic money supply is backed in a fixed exchange rate regime. As a result, two possibilities arise regarding the existence of steady states where credit is rationed. These possibilities are illustrated in figures 6a and 6b.

Figure 6a. For low (high) levels of the foreign inflation rate, credit is (is not) rationed. This situation tends to transpire in a Case 2 economy when x is relatively small.

Figure 6b. $f'(\tilde{k})$ lies everywhere above $\rho(\sigma^*)$ and credit is always rationed. This situation tends to transpire in a Case 2 economy when x is relatively large.

As a result, in economies where Case 2 obtains and a fixed exchange rate regime is in place, low levels of steady-state inflation will in general be associated with credit being rationed. Moreover, there will be inflation thresholds as are observed empirically:

foreign inflation and output are positively (negatively) correlated below (above) the threshold.

3.3 Dynamic Equilibria

This section takes up the analysis of dynamic equilibria under fixed exchange rates. It begins with an analysis of dynamics when credit is not rationed.

3.3.1 Dynamic System in a Walrasian Regime

The dynamic system in a Walrasian regime is given by (58) at equality, (59) and (60).

Equations (58) and (60) can be rewritten, respectively, as

$$\alpha A k_{t+1}^{\alpha-1} = \rho = \frac{\left[r - \frac{(\phi_d + \phi_f)}{(1 + \sigma^*)} \right]}{(1 - \phi_d - \phi_f)} \quad (73)$$

$$i_t^* = (1 - \alpha) A k_t^\alpha + \frac{[(1 - \lambda)\tau_t - k_{t+1}]}{\lambda(1 - \phi_d - \phi_f)} \quad (74)$$

Notice that (73) and (59) constitute a recursive dynamic system. Equation (73) implies that the capital-labor ratio is constant. Then (59) governs the dynamic behavior of the investment subsidy τ_t :

$$\tau_t = \left(\frac{G_1 + G_2}{1 - \lambda} \right) \hat{k} - G_2 \tau_{t-1}, \quad (75)$$

where G_1 and G_2 are as defined in (61). Finally, equation (74) can be rewritten as

$$i_t^* = (1 - \alpha) A \hat{k}^\alpha - \frac{\hat{k}}{\lambda(1 - \phi_d - \phi_f)} + \left[\frac{(1 - \lambda)}{\lambda(1 - \phi_d - \phi_f)} \right] \tau_t \quad (76)$$

Notice that the dynamic properties of τ_t (and, thus, of i_t^* too) are determined by

$\frac{\partial \tau_t}{\partial \tau_{t-1}} = -G_2$. Also notice that $G_2 > (<) 0$ under a currency board (pure fixed exchange rate

regime). Under a currency board, $\left| \frac{\partial \tau_t}{\partial \tau_{t-1}} \right| \geq 1$ can hold, while in a pure fixed exchange rate

regime typically $\frac{\partial \tau_t}{\partial \tau_{t-1}} \in (0, 1)$. When $-1 < \frac{\partial \tau_t}{\partial \tau_{t-1}} < 0$, as can occur with a currency board,

then fluctuations in the value of the investment subsidy can be observed. These fluctuations will then be translated into fluctuations in the magnitude of capital flows (net investment abroad). Notice that fluctuations in the government's fiscal position, and in net foreign investment can only occur if a currency board is in place. Such fluctuations are not possible under a pure fixed exchange rate regime. Thus, backing domestic currency with foreign assets does not prevent fluctuations in net foreign investment; rather, it can promote the occurrence of such fluctuations.

3.3.2 Dynamic System in a Credit Rationing Regime

The dynamic system under credit rationing is given by

$$r(1-\lambda)(1-\alpha)Ak_t^\alpha = \pi\alpha Ak_{t+1}^\alpha + [(1-\pi)x - \pi\rho]k_{t+1} + \pi\rho(1-\lambda)\tau_t, \quad (77)$$

(59), (74) and

$$\alpha Ak_{t+1}^{\alpha-1} > \rho \quad (78)$$

Equations (77), and (59) jointly govern the dynamics of the capital-labor ratio and the capital investment subsidy. Equation (74) then describes the dynamics of net foreign investment.

Rearranging terms in equations (77) and (59), and defining $q_t = \tau_{t-1}$, I obtain the following dynamic system:

$$k_{t+1} = -\left(\frac{G_2}{G_1}\right)k_t + \left(\frac{1-\lambda}{G_1}\right)\tau_t + \left[\frac{G_2(1-\lambda)}{G_1}\right]q_t = g(k_t, \tau_t, q_t) \quad (79)$$

$$\begin{aligned} \tau_{t+1} = & \left[\frac{r(1-\alpha)A}{\pi\rho}\right]k_{t+1}^\alpha - \left[\frac{\alpha A}{(1-\lambda)\rho}\right][g(k_{t+1}, \tau_{t+1}, q_{t+1})]^\alpha \\ & - \left[\frac{(1-\pi)x - \pi\rho}{(1-\lambda)\pi\rho}\right]g(k_{t+1}, \tau_{t+1}, q_{t+1}) \end{aligned} \quad (80)$$

$$q_{t+1} = \tau_t \quad (81)$$

Local Stability. I now linearize the dynamic system (79), (80) and (81) in a neighborhood of the nontrivial steady state. The Jacobian of the linearized system is

$$J(\tilde{k}, \tilde{\tau}, \tilde{q}) = \begin{bmatrix} g_1 & g_2 & g_3 \\ g_1 \left(\frac{P}{R} \right) & \left(\frac{S}{R} \right) & g_3 \left(\frac{P}{R} \right) \\ 0 & 1 & 0 \end{bmatrix}, \text{ where}$$

$$g_1 \equiv -\left(\frac{G_2}{G_1} \right) \quad g_2 \equiv \left(\frac{1-\lambda}{G_1} \right) \quad g_3 \equiv \left[\frac{G_2(1-\lambda)}{G_1} \right] \quad (82)$$

$$P \equiv r(1-\lambda)(1-\alpha)f'(\tilde{k}) - g_1[\alpha\pi f'(\tilde{k}) + (1-\pi)x - \pi\rho] \quad (83)$$

$$R \equiv (1-\lambda)\pi\rho + g_2[\alpha\pi f'(\tilde{k}) + (1-\pi)x - \pi\rho] \quad (84)$$

$$S \equiv r(1-\lambda)(1-\alpha)g_2 f'(\tilde{k}) - (g_1 g_2 + g_3)[\alpha\pi f'(\tilde{k}) + (1-\pi)x - \pi\rho] \quad (85)$$

It can be easily shown that the determinant of $J(\tilde{k}, \tilde{\tau}, \tilde{q})$ is equal to zero. Then, one of the eigenvalues of J will be equal to zero, while the remaining two eigenvalues are given by the roots η of the following quadratic equation:

$$\eta^2 - H_1\eta - H_2 = 0 \quad (86)$$

It can be shown that

$$H_1 \equiv g_1 + \left(\frac{S}{R} \right) = \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi G_2]f'(\tilde{k}) - G_2(1-\pi)x}{\pi\rho(G_1 - 1) + \alpha\pi f'(\tilde{k}) + (1-\pi)x} \quad (87)$$

and

$$H_2 \equiv (g_1 g_2 + g_3) \left(\frac{P}{R} \right) - g_1 \left(\frac{S}{R} \right) = \frac{G_2 r(1-\lambda)(1-\alpha)f'(\tilde{k})}{\pi\rho(G_1 - 1) + \alpha\pi f'(\tilde{k}) + (1-\pi)x} \quad (88)$$

As described above, G_1 and G_2 vary according to the nature of the fixed exchange rate regime. This, in turn, implies that the properties of dynamic equilibria near a

nontrivial steady state when credit is rationed differ according to whether or not a currency board is in place. In the remainder of this section I present numerical examples²⁶.

Case 1: $\alpha\pi > r(1 - \lambda)(1 - \alpha)$. When a Case 1 economy obtains, it is possible to observe the following:

A Currency Board regime

When Case 1 obtains and a currency board regime is in place, either both eigenvalues are real and negative or they are complex conjugates.

Typically, it is possible to observe the following:

a) For low levels of foreign inflation, the steady state is a saddle. Then, dynamic equilibria are determinate and damped oscillations will be observed along the stable manifold.

b) As σ^* increases, the nontrivial steady state becomes a sink. Therefore, the steady state is indeterminate and dynamic paths approaching it will display damped oscillations.

²⁶ The following parameter values were kept constant across scenarios in the numerical examples: $\phi_d = \phi_f = 0.085$, $r = 1.1$, $x = 1.05$, $\alpha = 0.35$, $A = 1$, and $\lambda = 0.7$. Notice that the values used for the domestic reserve requirements correspond to the actual values observed in Argentina. In order to obtain the conditions under which Case 1 obtains, I used $\pi = 0.95$, while for Case 2 I used $\pi = 0.05$. Obviously, $\theta = \xi = 0$ when there is a pure fixed exchange rate regime, while the values $\theta = 1$ and $\xi \in \{0, 0.1, 0.2, 0.5\}$ defined the different scenarios simulated for a currency board.

c) For high rates of foreign inflation, the eigenvalues become complex conjugates of the form $\left(\frac{H_1}{H_2}\right) \pm \left(\frac{\sqrt{-H_1^2 - 4H_2}}{2}\right) \cdot i$, where $i \equiv \sqrt{-1}$. Moreover, the modulus of the complex eigenvalues, given by $\sqrt{-H_2}$, is an increasing function of σ^* , but it seems that it is never greater than 1. Thus, the nontrivial steady state is a sink with complex roots.

Interestingly, complex eigenvalues are more likely to be observed whenever the policy parameter ξ is relatively large. It is possible that the eigenvalues are complex conjugates for all levels of σ^* when ξ is large enough. On the other hand, when $\xi=0$, no complex roots seem to be observed. Thus backing domestic deposits with government-held foreign currency reserves promotes endogenously generated volatility.

A Pure Fixed Exchange Rate regime

When Case 1 obtains and a pure fixed exchange rate regime is in place, we typically observe that both eigenvalues are real, distinct and positive. Moreover, $\forall \sigma^* > \left(\frac{1}{r} - 1\right)$, the steady state is a saddle and dynamic paths approach the steady state monotonically. Dynamic equilibria are then determinate. As σ^* increases, the magnitude of the stable (unstable) eigenvalue decreases (increases).

Case 2: $\alpha\pi < r(1 - \lambda)(1 - \alpha)$. When a Case 2 economy obtains, it is possible to observe the following:

A Currency Board regime

In a currency board regime, both eigenvalues will be real and distinct, with opposite signs. The positive eigenvalue will typically be less than one and decreasing in σ^* . On the other hand, it is possible for the negative eigenvalue to be greater or less than -1, depending on the magnitude of ξ and σ^* . Moreover, the negative eigenvalue is decreasing in these parameters. Therefore, it will be possible to observe the following:

a) If ξ is relatively large:

a.1) For low rates of foreign inflation, the nontrivial steady state is a sink with dynamic paths that display damped oscillations. Therefore, dynamic equilibria are indeterminate.

a.2) As σ^* increases, the steady state becomes a saddle. Then, dynamic equilibria will be determinate and no oscillations will be observed along the stable manifold.

b) If ξ is relatively low:

b.1) For low values of σ^* , the nontrivial steady state is a sink, and dynamic paths will display monotonic convergence. Dynamic equilibria are, thus, indeterminate.

b.2) For high levels of foreign inflation, the steady state is still a sink, but dynamic paths will display damped oscillations. Dynamic equilibria are still indeterminate.

It is worth noticing that as $\xi \rightarrow 0$, the scope for economic fluctuations is reduced for given levels of foreign inflation, and the steady state becomes a sink with dynamic paths that display monotonic convergence.

A Pure Fixed Exchange Rate regime

In a pure fixed exchange rate regime, the steady state is always a sink with real and positive eigenvalues. Thus, there is again an indeterminacy of dynamic equilibria. However, endogenous volatility cannot be observed near the steady state.

4 Conclusions

This paper presents a model of a small open economy where financial intermediaries perform a real allocative function in the presence of multiple reserve requirements and obvious credit market frictions that may or may not cause credit to be rationed. I then consider the relative merits of different exchange regimes along several dimensions including the attainment of low and stable rates of inflation, the promotion of financial deepening, and the avoidance of stagnation in output. I focus my attention on policies that have been implemented in Latin America and, particularly, in Argentina and Perú.

Concerning economies with floating exchange rates, I find that changes in domestic inflation and world (U.S.) inflation affect the domestic capital stock differently according to whether or not credit is rationed. What matters when credit is rationed is how the domestic and foreign rates of inflation affect the self-selection constraint, and they affect this differently. In marked contrast to the literature on closed economies, either credit rationing tends to be observed when domestic rates of inflation are low, or else the scope for credit to be rationed depends in a relatively complicated way on the rate of money creation (inflation). In the first situation, moderate increases in the rate of money growth (inflation) stimulate output when credit is rationed (inflation is initially low), but reduce output when there is no credit rationing (inflation is initially high). Thus there will be inflation thresholds as are observed empirically: inflation and output are positively (negatively) correlated below (above) the threshold. As a consequence, there is

a strict limit to the extent to which domestic inflation can be used to stimulate output. Furthermore, the presence of credit rationing seems to increase the scope for both instability and economic fluctuations. When the second situation obtains, however, increases in the domestic rate of inflation always have adverse consequences for real activity and private information (together with high rates of inflation) seems to increase the scope for indeterminacy of dynamic equilibria and for economic fluctuations.

In a small open economy with a fixed rate of exchange, the domestic and foreign inflation rates will be equal. Interestingly again -and, yet in marked contrast to the literature on closed economies- either the scope for credit to be rationed depends in a relatively complicated way on the rate of foreign inflation, or credit rationing tends to be observed when foreign rates of inflation are low. In the first situation, increases in the foreign (and domestic) rate of inflation always have adverse consequences for real activity. In the second situation, however, there will be inflation thresholds: foreign (and domestic) inflation and output are positively (negatively) correlated below (above) the threshold.

Finally, in economies with fixed exchange rates, a currency board seems to increase the scope for economic fluctuations. Such potential for fluctuations disappears as the backing of the domestic money supply and deposits is reduced. Moreover, indeterminacy of dynamic equilibria may be observed independently of the backing of the domestic money supply. And, in economies with fixed exchange rates, the potential

for indeterminacy and fluctuations seems to be positively related to the (world) rate of inflation.

Chapter II

Disruptions of Liquidity, International Financial Crises and Monetary Integration**

Abstract

Can a reserve crisis in one country affect welfare and output in another country through the operation of international financial markets? What are the implications of sharing a common outside currency for the transmission of financial crises across countries?

This paper models a financial center and periphery reproducing various aspects of the historical International Gold Standard. This period was characterized by frequent crises associated with scarce stocks of reserves, plus high short-term interest rates with subsequent gold inflows and effects on output across countries.

A common international currency and no legal restrictions on exchange help the periphery share reserves with the financial center, mitigating the output losses due to financial crises. The center has incentives for restrictive rediscounting while the periphery has motives for developing central banking.

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International reserve crises; Monetary integration; Rediscounting.

1 Introduction

A reserve crisis is defined as a lack of nominal means of payment that prevents otherwise risk-free debt from being repaid at par in one country. Can a reserve crisis in one country affect output and welfare in another country through the operations of international financial markets? And, what are the implications of sharing a common outside currency for the transmission of financial crises across countries? This paper constitutes an effort to answer these questions.

To address the questions posed, this paper models two countries, a financial center and a financial periphery, under two monetary regimes: a common international currency versus separate national currencies. The focus is on disruptions of liquidity caused by a lack of the means of payment –without imposing any price rigidity– which prevents a financial obligation from being settled at its promised value (see Freeman, 1996a). Therefore, the main characteristic of the financial crises studied in this paper is the inadequate supply of the means of payment, without which otherwise risk-less debts fail to be repaid at par. This failure, in turn, affects the payments to factors of production (e.g. wages), with consequent real effects.

Output can be low simply because the nominal stock of money reserves available is too low. Freeman's result (Freeman, forthcoming 2002) raises the question of whether international financial integration can help: is it possible to (partially or totally) overcome this nominal constraint on output through free access to international financial markets in

a world with a common currency? As I show, the possibility of reserve-sharing between a financial center and a periphery helps the periphery to increase output by importing (gold) reserves when its nominal money supply would otherwise be low. Even so, not all the equilibrium allocations maximize steady-state utility for the world economy.

How this situation differs from the one arising in the presence of two country-specific currencies depends on the presence or absence of foreign exchange controls. When there are strong limitations on the use of foreign currency in the domestic country, a disruption of liquidity in the financial periphery can not be overcome: no trade occurs in the foreign exchange markets, there is financial autarky and the domestic output can be constrained by the nominal stock of domestic currency. In the case when there are multiple currencies but no controls on foreign exchange, there is still international financial integration, a result that is not surprising in view of the fact that the indeterminacy of the exchange rate found by Kareken and Wallace (1981) continues to obtain.

The International Gold Standard (1821-1931) was a period of severe and frequent crises associated with scarce stocks of reserves. This period was characterized by a fixed exchange rate regime in which countries redeemed domestic currencies in gold, with England as the world's financial center. Bordo (1984) argues that declines (rises) in the domestic money stock led to increases (falls) in short-term interest rates and, consequently inflows (outflows) of reserves from abroad. Huffman and Lothian (1984), when analyzing historical data for the United Kingdom and the United States, found a

clear association between decreases in the rate of growth of money and cyclical fluctuations in output:

... In almost all of the episodes a clear-cut association is evident between monetary decelerations and movements in output. That association, moreover, does not appear to be simply a reflection of reverse causation.

For one thing the monetary shocks, as we have measured them, in almost all instances preceded or were coincident with the cyclical contractions. In relatively few instances did monetary deceleration come after the fact.¹

These authors also point out two additional findings. First, they observe that, in general, the magnitude of the reductions in the money supply conformed to the severity of the decline in output. Second, they also notice that flows of specie-reserves as well as price and capital-market adjustments played an essential role in the transmission across countries of these monetary and real downturns.

In contrast to the studies described, this paper focuses on output declines associated with reductions in the stocks of reserves, instead of reductions in the overall money supply. The paper can be thought of as comparing the experiences of the United Kingdom and the United States in two different periods with two distinct international monetary arrangements: the Antebellum period (before 1862) and the Greenback period (1862-1879). During both periods the United Kingdom was the world's financial center. In both periods there were financial crises in which the origin of the business contractions was a drain of specie-reserves in the United Kingdom, followed by a reaction of the Bank of England. However, each period was characterized by different international monetary regimes: during the Antebellum period both countries were on gold, while during the

¹ Huffman and Lothian (1984), pp. 478-479.

Greenback period only one country (the United Kingdom) was on gold. As we can see in Tables 1a, 1b, 2a and 2b, only during the Antebellum period, when both countries were on gold, do we observe that monetary and business contractions spread from the United Kingdom (the financial center) to the United States. In contrast, in the business contraction of 1866 (during the Greenback period), the United States was off of gold and the monetary and business contraction that originated in the United Kingdom was confined to that country.

The paper is organized as follows. In Section 2, I present the two-country, single currency model. I then argue that international financial integration works to some extent to provide an “elastic currency” when some specific institutional arrangements are present. In Section 3, I consider a world with country-specific currencies, flexible exchange rates, and controls on foreign exchange. Next, in Section 4, I examine in more detail the historical observations on financial crises on the United Kingdom and the United States during the International Gold Standard and I compare them with the predictions of the model presented in Sections 2 and 3. Finally, in Section 5, I describe the main conclusions of the analysis.

2 A Single Currency World

In this section, I present a two-country model. Each country, in autarky, has the features introduced by Freeman (forthcoming 2002). Both countries share a fixed stock of outside currency, which I call gold but which has no intrinsic value². The two countries are identical in every respect but in the size of their financial sector and in the fact that only Country 2's agents face stochastic fluctuations in their needs for liquidity. Country 1 (the United States) is the financial periphery and Country 2 (the United Kingdom) is the financial center. Country 2 is the financial center because it has a larger volume of reserves to cover the needs of trade. For simplicity, we assume that the volume of trade in both countries is normalized to be equal. In this case, Country 2's financial sector (population of bankers) is larger than Country 1's.

2.1 Endowments, Preferences and Production

Each country consists of an infinite sequence of two period lived, overlapping generations. In each country there is a constant population. In addition, in both countries there is a central island surrounded by groups of outer islands.

² It is easy to “marry” the economy considered here with the commodity money model of Sargent and Wallace (1983). For simplicity, I do not do that here.

There are three types of agents in each generation who each live on a separate outer island: capitalists, debtors and bankers. In Country i ($i=1,2$), in a given generation, there is a continuum of capitalists with unit mass, a continuum of debtors with unit mass, and a continuum of bankers with mass y_i . I assume that $y_1 < 1$. We will see that in equilibrium, this assumption implies that Country 1 is liquidity constrained in autarky, which means that gold reserves will be insufficient to settle all debt at par. In addition, since Country 2 is the financial center, I assume that $y_1 < y_2$.

Each capitalist in each country is endowed when young with one unit of a specific good, and with an investment technology that allows him to transform one unit of the endowment good at time t (only if saved) into one unit of physical capital at $t+1$. When old he can use this capital together with hired labor to produce $F(k_{it}, L_{i,t+1})$ units of a consumption good, where k_{it} and $L_{i,t+1}$ denote, respectively, physical capital and labor used by a capitalist born in Country i at t . $F(.,.)$ is a constant returns to scale and twice continuously differentiable production function with the following properties: $F_K > 0$, $F_L > 0$, $F_{KK} < 0$, $F_{LL} < 0$, and, $F_{KL} > 0$. I also assume that $F(0, L) = F(k, 0) = 0$ (both physical capital and labor are essential for production). Note that investment and the production technologies are homogeneous across countries. Finally, the initial old capitalists in both countries are endowed with $k_0 > 0$ units of physical capital each.

Each debtor and banker is endowed with one unit of non-storable labor when young (and nothing when old). Labor is homogeneous across countries and agent types.

A capitalist born in Country i at t only wishes to consume when old the final (consumption) good he produces ($\tilde{c}_{i,t+1}$). His utility is monotonically increasing in this argument. A debtor born in Country i wishes to consume only the capitalist's endowment good when young (c_{it}) and nothing when old; his utility is monotonically increasing in this argument. Finally, a banker born in Country i consumes only the services produced by other people's labor when old ($n_{i,t+1}$), and his utility is monotonically increasing in this argument. For simplicity, I will assume that each agent's utility is linear in its arguments.

In the initial period, there exists a fixed stock of M units of gold in the world, which is distributed equally among the initial old capitalists and bankers.

2.2 Interaction between Countries and Trade and Travel Patterns

Even though investment and production technologies are homogeneous across countries, for simplicity, I focus on the case in which the capitalists' endowment good, physical capital and the capitalists' final good are island-specific. Therefore, the capitalists' endowment good, physical capital, and the capitalists' final good are not internationally

mobile. On the other hand, labor markets are competitive and there is free mobility of labor across countries, so that wages are equalized across all locations.

In addition, there is free mobility of gold reserves across countries.

I now describe the timing of events and the nature of transactions within a period.

2.2.1 Young agents

At the beginning of each period, trade in the capitalists' endowment good takes place in both countries. Young debtors would like to buy some of this good from the young capitalists of their country. To do so, they issue debt for the nominal value of the amount of the good they want to purchase, to be repaid in gold (money)³. The young capitalists accept this debt in exchange for part of their endowment good, and invest the rest in capital. The young debtors then go back to their island with the amount of the capitalists' endowment good they purchased and consume it.

During the second stage of a period, labor markets open. As already noted, there is free mobility of labor across countries. Thus, young debtors and young bankers travel to the old capitalists' and old bankers' islands either in their own country or in the foreign country to supply labor inelastically in exchange for money (gold). Note that the free

³ It may be useful to note at this point that in this environment, in equilibrium, the interest rate on the debt issued by the young debtors will be fixed by the rate of return on money (gold). Therefore, it will be the price of the young capitalists' endowment good that will adjust to clear the market for loans. This will occur because in each country the young debtors will use the loans only to purchase the goods of the island-specific capitalists' endowment good in their own country.

mobility of labor implies that the nominal wage rate is equalized across both islands and countries.

2.2.2 Old agents

When old, all the agents must travel to a central island. Notice that the arrivals of the different types of old agents will not be synchronized. On the other hand, note that the bilateral clearing of debt would require that the old debtors bring enough gold balances to the central island while the old capitalists are there.

When the first stage of a period begins, the old capitalists travel to the central island in their country. They can remain at a central island only during the first stage of the period. However, at this time, none of Country 1's old debtors have arrived yet, while only a fraction λ_{t+1} of Country 2's old debtors have arrived at their own country's central island. Therefore, the bilateral clearing of debt cannot occur at this time. The serially uncorrelated random variable λ_{t+1} has a strictly stationary distribution with support on the interval $(0, 1)$. The realization of λ_{t+1} is known at the beginning of period $t+1$. Notice that λ_{t+1} will represent the availability of reserves in the financial center at $t+1$.

At the same time, the old bankers arrive at a central island. Notice that the old bankers can wait for the remaining of the old debtors to arrive the next stage of the period, while the old capitalists cannot. The old capitalists, instead of going back home

with no money balances, sell the debt in their hands to the old bankers in exchange for gold. Profit seeking by the bankers gives room for a resale market for debt to open. Moreover, the old bankers are free to take reserves to any central island they want. Therefore, the old bankers use gold balances (reserves) to purchase debt from the old capitalists until the resale price of the debt is equalized across central islands. Figure 7 illustrates the transactions performed by the old agents during the first stage of a period.

Note that a lack of nominal means of payment may arise during the first stage of a period at the world level. Specifically, there is a shortage of liquidity if the total of reserves available in both central islands⁴ are scarce relative to the face value of the not-yet-cleared debt held by the old capitalists of both countries. At the end of this stage, the old capitalists sell their debt to the old bankers and go back to their island with the gold received. The old bankers stay on the central island waiting for the remaining old debtors to arrive.

At the beginning of the second stage of a period, the remaining old debtors arrive at their own country's central island and repay their debt to the old bankers. Next, all the old agents go back to their own islands and the competitive labor market opens. Notice that the debt needs to be cleared before the labor market opens because both old bankers and old capitalists must carry gold balances in order to purchase labor. Figure 8 illustrates the transactions performed by the old agents during the second stage of a period, before the labor market opens.

⁴ The total reserves available in both central islands at this time are given by the total of gold balances held by the old bankers.

At the end of the second stage, the old bankers purchase labor for consumption. On the other hand, the old capitalists use both the labor they purchased this period and the capital they invested in when young to produce the final good and they consume it.

2.3 Equilibrium

2.3.1 Behavior of Individual Agents

Debtors

Let p_{it} denote the unit price (in gold) of the capitalists' endowment good faced by a young debtor born in Country i at time t , and c_{it} his consumption of this good. Let w_{it} be the nominal wage in Country i at t , d_{it} the nominal value of the debt issued by a young debtor born in Country i at t , and m_{it} his nominal balances of gold. The collapsed budget constraints that describe the debtor's behavior are:

$$p_{it}c_{it} = d_{it} = m_{it} = w_{it}, \quad i=1,2 \quad (1)$$

Capitalists

Let s_{it} be the nominal value of the debt accepted by a young capitalist born in Country i at t and let k_{it} be his investment in physical capital. A young capitalist born in Country i

at t can either invest his endowment of the island-specific good or sell it to a young debtor. His budget constraint is

$$1 = \frac{S_{it}}{p_{it}} + k_{it}, \quad i = 1, 2 \quad (2)$$

Define $L_{i,t+1}$ to be the amount of labor that a capitalist born in Country i at t buys when old and let $q_{i,t+1}$ be the resale price of the debt on Country i 's central island at time $t+1$. The budget constraints that define the purchases of labor by an old capitalist born in Country 1 at t and an old capitalist born in Country 2 at t are, respectively

$$q_{1,t+1}s_{1t} = w_{1,t+1}L_{1,t+1} \quad (3a)$$

$$[\lambda_{t+1} + (1 - \lambda_{t+1})q_{2,t+1}]s_{2t} = w_{2,t+1}L_{2,t+1} \quad (3b)$$

An old capitalist born in Country i at t will use physical capital and labor to produce an island-specific final good. Let $\tilde{c}_{it}$ denote his consumption of this good. Then

$$\tilde{c}_{i,t+1} = E_t \{F(k_{it}, L_{i,t+1})\}, \quad i = 1, 2 \quad (4)$$

From (2), (3a) and (4), it follows that the problem to be solved by a capitalist born in Country 1 is

$$\underset{k_{1t}}{Max} \quad E_t \left\{ F \left[k_{1t}, \frac{q_{1,t+1} p_{1t} (1 - k_{1t})}{w_{1,t+1}} \right] \right\} \quad (5a)$$

taking $q_{1,t+1}$, p_{1t} and $w_{1,t+1}$ as given. The first order condition (interior solution) for this problem is:

$$E_t \left\{ F_K \left[k_{1t}, \frac{q_{1,t+1} p_{1t} (1 - k_{1t})}{w_{1,t+1}} \right] \right\} = E_t \left\{ \left(\frac{q_{1,t+1} p_{1t}}{w_{1,t+1}} \right) F_L \left[k_{1t}, \frac{q_{1,t+1} p_{1t} (1 - k_{1t})}{w_{1,t+1}} \right] \right\} \quad (6a)$$

Similarly, from (2), (3b) and (4), the problem that a capitalist born in Country 2 has to solve becomes

$$\underset{k_{2t}}{Max} \quad E_t \left\{ F \left[k_{2t}, \frac{[\lambda_{t+1} + (1 - \lambda_{t+1}) q_{2,t+1}] p_{2t} (1 - k_{2t})}{w_{2,t+1}} \right] \right\} \quad (5b)$$

taking $q_{2,t+1}$, p_{2t} and $w_{2,t+1}$ as given. The first order condition (interior solution) for this problem is:

$$\begin{aligned} & E_t \left\{ F_K \left[k_{2t}, \frac{[\lambda_{t+1} + (1 - \lambda_{t+1}) q_{2,t+1}] p_{2t} (1 - k_{2t})}{w_{2,t+1}} \right] \right\} \\ &= E_t \left\{ \left(\frac{[\lambda_{t+1} + (1 - \lambda_{t+1}) q_{2,t+1}] p_{2t}}{w_{2,t+1}} \right) F_L \left[k_{2t}, \frac{[\lambda_{t+1} + (1 - \lambda_{t+1}) q_{2,t+1}] p_{2t} (1 - k_{2t})}{w_{2,t+1}} \right] \right\} \quad (6b) \end{aligned}$$

Equations (6a) and (6b) require that the expected return on physical capital equals the expected return on gold-reserves.

Bankers

Let m_{it}^* be the nominal balances of gold held by a young banker born in Country i at t . A young banker supplies labor inelastically in exchange for gold. Hence, the budget constraint faced by a young banker born in Country i is:

$$m_{it}^* = w_{it}, \quad i = 1, 2 \quad (7)$$

When old, a banker born in Country i uses his balances of gold to purchase debt from the old capitalists. He can take any fraction $x_{i,t+1} \in [0,1]$ of his balances of gold (reserves) to the other country's central island and buy foreign debt, using the remaining reserves to acquire domestic debt. Once the old debtors repay their debt, an old banker born in Country i spends all the profits earned in the purchase of labor. He can buy labor from any country he wants. Let $n_{i,t+1}$ be the total consumption of labor by an old banker born in Country i at t . The budget constraint of an old banker is given by:

$$w_{i,t+1}n_{i,t+1} = \frac{x_{i,t+1}m_{it}^*}{q_{j,t+1}} + \frac{(1-x_{i,t+1})m_{it}^*}{q_{i,t+1}} \quad (8)$$

2.3.2 Market Clearing Conditions

As a consequence of free international mobility of the labor supply, there is a single world market for labor. This market clears when the world aggregate supply of labor equals the world aggregate demand for labor:

$$(2 + y_1 + y_2) = L_{1,t+1} + L_{2,t+1} + y_1n_{1,t+1} + y_2n_{2,t+1} \quad (9)$$

On the other hand, in this environment the young workers (debtors and bankers) are the only holders of gold balances. Therefore, as a result of a single world market for labor, the market for gold is also integrated at the world level. This market clears when the world aggregate demand for gold equals the world fixed supply:

$$m_{1t} + m_{2t} + y_1 m_{1t}^* + y_2 m_{2t}^* = M \quad (10)$$

Equations (1), (7) and (10) imply that

$$(1 + y_1)w_{1t} + (1 + y_2)w_{2t} = M \quad (11)$$

In addition, free internal mobility of the labor supply and competitive markets imply nominal wage equalization across countries, so that

$$w_{1t} = w_{2t} = w_t = \frac{M}{(2 + y_1 + y_2)} \quad \forall t \quad (12)$$

However, the demand for the capitalists' endowment good is island-specific. This implies that the domestic markets for loans are not internationally integrated. Therefore, Country i 's market for loans clears when

$$d_{it} = s_{it}, \quad i = 1, 2 \quad (13)$$

In equilibrium, the old bankers transfer reserves across central islands until the resale price of the debt is equalized across countries:

$$q_{1,t+1} = q_{2,t+1} = q_{t+1}, \quad \forall t \geq 1 \quad (14)$$

Also, in equilibrium, the debt offered by the old capitalists cannot exceed the balances of gold brought to the central islands by the old bankers. Therefore, at time $t+1$, the resale market for debt clears when

$$q_{t+1}[s_{1t} + (1 - \lambda_{t+1})s_{2t}] \leq (y_1 m_{1t}^* + y_2 m_{2t}^*) \quad (15)$$

Equation (15) holds with strict equality if there is a shortage of reserves with which to clear the debt:

$$[s_{1t} + (1 - \lambda_{t+1})s_{2t}] > (y_1 m_{1t}^* + y_2 m_{2t}^*) \quad (16)$$

If this is the case, the debt is sold at a discount ($0 < q_{t+1} < 1$) in order to clear this market.

Also, after combining (16) with the relevant equilibrium conditions, we can say that there is a shortage of reserves with which to clear the debt at period $t+1$ if:

$$(y_1 + y_2) < (2 - \lambda_{t+1}) \quad (17)$$

If inequality (17) holds for all the possible realizations of λ_{t+1} , we say that the world economy is liquidity-constrained. In contrast, we say that there are plentiful reserves in the central islands when

$$[s_{1t} + (1 - \lambda_{t+1})s_{2t}] \leq (y_1 m_{1t}^* + y_2 m_{2t}^*) \quad (18)$$

In this case, debt is sold at par ($q_{t+1}=1$), and the value of debt sold clears this market.

After some substitutions, we are able to say that there are plentiful reserves at $t+1$ if

$$(y_1 + y_2) \geq (2 - \lambda_{t+1}) \quad (19)$$

If equation (19) holds for all the possible realizations of λ_{t+1} , we say that the world economy is not liquidity-constrained. The analysis that follows focuses on the case in which (17) holds, i.e., the world economy is liquidity-constrained for all the relevant values of λ_{t+1} .

Finally, for a given q_{t+1} , the short-run gross interest rate (liquidity premium) prevailing on the central islands between the departure of the old capitalists and the arrival of the old debtors is given by $\left(\frac{1}{q_{t+1}} \right)$.

2.3.3 General Equilibrium⁵

Let $q_{i,t+1}^a$ denote the resale price of the debt in Country i in the equilibrium with no financial integration (financial autarky) at $t+1$, where the superscript a denotes the autarkic equilibrium.

The proofs of the following propositions can be found in Appendix B.

Proposition 1. *If, as assumed, $y_1 < y_2$, then, in the equilibrium with no financial integration (financial autarky), the resale price of the debt in the financial periphery ($q_{1,t+1}^a$) is lower than in the financial center ($q_{2,t+1}^a$).*

Proposition 2. *In the liquidity-constrained world-integrated equilibrium, when there is a common outside currency, the following holds as a result of arbitrage in the resale market for debt: a) the financial center shares gold-reserves with the financial periphery,*

and b) the liquidity premium is such that $\left(\frac{1}{q_{2,t+1}^a}\right) < \left(\frac{1}{q_{t+1}}\right) < \left(\frac{1}{q_{1,t+1}^a}\right)$.

Given Propositions 1 and 2, the combination of (12) and (14) with (6a) defines the equilibrium choice of physical capital by a capitalist born in Country 1 at t :

$$E_t \left\{ F_k \left[k_{1t}, \frac{q_{t+1} w_t}{w_{t+1}} \right] \right\} = E_t \left\{ \left(\frac{q_{t+1} p_{1t}}{w_{t+1}} \right) F_L \left[k_{1t}, \frac{q_{t+1} w_t}{w_{t+1}} \right] \right\} \quad (20a)$$

⁵ It can be shown that all the results in this section and in the remaining sections hold also for the case when no mobility of the labor supply is allowed across countries. We can assume international mobility in either labor supply or labor demand. Therefore, mobility of old bankers (labor demand) is sufficient, without mobility of workers (labor supply).

Equivalently, by combining (12) and (14) with (6b), we can define the equilibrium choice of physical capital by a capitalist born in Country 2 at t :

$$\begin{aligned}
& E_t \left\{ F_k \left[k_{2t}, \frac{[\lambda_{t+1} + (1 - \lambda_{t+1})q_{t+1}]w_t}{w_{t+1}} \right] \right\} \\
& = E_t \left\{ \left(\frac{[\lambda_{t+1} + (1 - \lambda_{t+1})q_{t+1}]p_{2t}}{w_{t+1}} \right) F_L \left[k_{2t}, \frac{[\lambda_{t+1} + (1 - \lambda_{t+1})q_{t+1}]w_t}{w_{t+1}} \right] \right\} \quad (20b)
\end{aligned}$$

On the other hand, Proposition 2 combined with equations (7), (8) and (12) implies that, in equilibrium, the consumption of labor by old bankers born at t is equalized across countries and is given by:

$$n_{1,t+1} = n_{2,t+1} = \frac{w_t}{w_{t+1}q_{t+1}} \quad (21)$$

2.3.4 Steady-State Equilibrium

From equation (12), it is clear not only that there is ex-ante and ex-post wage equalization across countries but also that the nominal wage is constant over time. In addition, while the financial center will share gold-reserves with the periphery during the first stage of each period, nominal wage equalization across countries and a constant wage rate imply a constant end-of-period supply of gold in each country. Therefore, for any given initial distribution of the world supply of gold, no redistribution of wealth (gold) across

countries occurs in equilibrium and the world economy remains in a (stochastic) steady-state equilibrium after the first period.

2.4 Optimality

In this section, we state the conditions that must be satisfied by a Golden Rule allocation in the world economy. Then, we compare the steady-state integrated competitive equilibrium with the Golden Rule allocation.

2.4.1 The Golden Rule

Consider a benevolent social planner that maximizes a weighted average of the agents' steady-state utility, subject only to feasibility constraints⁶. This problem may be stated as follows:

$$\underset{\substack{\tilde{c}_1, \tilde{c}_2, c_1, c_2, n_1, n_2 \\ k_1, k_2, L_1, L_2}}{\text{Max}} \quad \gamma_1 \tilde{c}_1 + \gamma_2 \tilde{c}_2 + \gamma_3 c_1 + \gamma_4 c_2 + \gamma_5 y_1 n_1 + \gamma_6 y_2 n_2 \quad (22)$$

$$\text{s.t.} \quad \tilde{c}_1 + \tilde{c}_2 = F(k_1, L_1) + F(k_2, L_2) \quad (23)$$

$$c_1 + c_2 + k_1 + k_2 = 2 \quad (24)$$

$$L_1 + L_2 + y_1 n_1 + y_2 n_2 = 2 + y_1 + y_2 \quad (25)$$

⁶ The planner does not have to respect any constraints on the timing of the transfers.

The relevant necessary first order conditions of this problem state that, for the world economy to reach the Golden Rule allocation, the following must hold:

$$\frac{F_L(k_1^{GR}, L_1^{GR})}{F_K(k_1^{GR}, L_1^{GR})} = \frac{F_L(k_2^{GR}, L_2^{GR})}{F_K(k_2^{GR}, L_2^{GR})} \quad (26)$$

where k_i^{GR} and L_i^{GR} denote Country i 's allocation of physical capital and labor, respectively, under the Golden Rule. Hence, when the world economy is in the Golden Rule allocation, the ratio of marginal product of labor to marginal product of capital in both countries must be equal.

2.4.2 Integrated Competitive Equilibrium and the Golden Rule

In this section, for the sake of comparability, I consider a steady-state competitive equilibrium where the young agents born at t know the value of λ_{t+1} at the moment of making their decisions.

Proposition 3. *The liquidity-constrained world-integrated steady-state competitive equilibrium, when there is a common outside currency, does not satisfy the Golden Rule.*

Proof: In the steady-state competitive equilibrium, the following holds:

$$\frac{F_L(k_1, L_1)}{F_K(k_1, L_1)} = \frac{w}{q_{1,t+1} p_{1t}} \quad (27a)$$

$$\frac{F_L(k_2, L_2)}{F_K(k_2, L_2)} = \frac{w}{[\lambda_{t+1} + (1 - \lambda_{t+1})q_{2,t+1}]p_{2t}} \quad (27b)$$

From (26), (27a) and (27b), a necessary condition for the competitive equilibrium to coincide with the Golden Rule is the following:

$$q_{1,t+1} \left(\frac{p_{1t}}{w} \right) = [\lambda_{t+1} + (1 - \lambda_{t+1})] q_{2,t+1} \left(\frac{p_{2t}}{w} \right) \quad (28)$$

However, from (1), (2), (12), (13), (20a) and (20b), equation (28) is satisfied if and only if

$$q_{1,t+1} = q_{2,t+1} = q_{t+1} = 1 \quad (29)$$

and $p_{1t} = p_{2t}$. Combining (1), (2), (12) and (13), we get:

$$p_{it} = \frac{w}{(1 - k_{it})}, \quad i = 1, 2 \quad (30)$$

Thus, for $p_{1t} = p_{2t}$ also $k_{1t} = k_{2t}$ is needed. From (20a) and (20b), this is true only when (29) holds.

Therefore, for the world economy to reach the Golden Rule allocation, not only must there be international financial integration, but in addition the nominal constraint on output (the liquidity constraint) must not be operative. The latter is not true in the integrated equilibrium when the world economy is liquidity-constrained. Q.E.D.

2.5 Liquidity Shocks and Output

This section discusses the effects, in a (stochastic) steady state, of unforeseen changes in the needs for liquid reserves on both output⁷ and the profits earned by the reserves-holding sector. The analysis focuses on the consequences of innovations in λ_t , which represent unforeseen and unpredictable changes in the availability of reserves in the financial center at time t . Notice that an increase in λ_t is equivalent to having more reserves available for the purchase of debt in the financial center at t . Given the nature of the shocks under consideration, the stock of physical capital used by the old capitalists to produce their final good at t will not be affected.

Let Y_{it} denote the stationary nominal value of output in Country i at time t . Then

$$Y_{it} \equiv \rho_{it} F(k_i, L_{it}), i=1,2 \quad (31)$$

where ρ_{it} denotes the nominal (shadow) price of the capitalist's final good in Country i .

Proposition 4. *In the liquidity-constrained world-integrated equilibrium, when there is a common outside currency, innovations in the needs for liquidity in the financial center (reductions in λ_t) reduce (capital-based) output not only in the financial center but also in the periphery.*

Proof: A sufficient condition for Proposition 4 to hold is that Y_{1t} and Y_{2t} are increasing in λ_t . Arbitrage in labor markets equates wages across sectors in Country i :

⁷ Output refers to the production of the island-specific final good by an old capitalist.

$$\rho_{it} = \frac{w}{F_L(k_i, L_{it})}, i = 1, 2 \quad (32)$$

Using (32), the constant returns to scale property of the production function, the fact that k_i remains constant, and defining $g(L_{it}) \equiv \left[\frac{k_i F_K(k_i, L_{it})}{F_L(k_i, L_{it})} \right]$, we can rewrite

Country i 's nominal physical output as

$$Y_{it} = w[L_{it} + g(L_{it})], i = 1, 2 \quad (33)$$

Using (33), it is easy to show that

$$\frac{\partial Y_{it}}{\partial \lambda_t} = w[1 + g'(L_{it})] \left(\frac{\partial L_{it}}{\partial \lambda_t} \right), \forall i = 1, 2 \quad (34)$$

Notice that, in the (stochastic) steady-state equilibrium, $L_{1t} = (y_1 + y_2)/(2 - \lambda_t)$ and $L_{2t} = [\lambda_t + (1 - \lambda_t)(y_1 + y_3)/(2 - \lambda_t)]$. Using the properties of $F(k_i, L_{it})$ and the relevant budget constraints, it is easy to show that

$g'(L_{it}) > 0$, $\frac{\partial L_{1t}}{\partial \lambda_t} > 0$ and $\frac{\partial L_{2t}}{\partial \lambda_t} > 0$. Hence, it follows that

$$\frac{\partial Y_{it}}{\partial \lambda_t} = w[1 + g'(L_{it})] \left(\frac{\partial L_{it}}{\partial \lambda_t} \right) > 0, \forall i = 1, 2 \quad (35)$$

Q.E.D.

Next, define Π_{it} as the gross nominal profits earned by the owners of gold-reserves (old bankers) in Country i at time t :

$$\Pi_{it} \equiv w y_i n_{it}, i = 1, 2 \quad (36)$$

Proposition 5. *In the liquidity constrained world-integrated equilibrium, when there is a common outside currency, innovations in the needs for liquidity in the financial center (reductions in λ_{t+1}) increase the gross profits earned by the reserves-holding sector in both the financial center and periphery.*

Proof: A sufficient condition for Proposition 5 to hold is that Π_{1t} and Π_{2t} are increasing in λ_t . Using (36), it is easy to show that

$$\frac{\partial \Pi_{it}}{\partial \lambda_t} = w y_i \left(\frac{\partial n_{it}}{\partial \lambda_t} \right), \forall i = 1, 2 \quad (37)$$

Notice that, from (21), in the (stochastic) steady-state equilibrium $n_{1t} = n_{2t} = (2 - \lambda_t) / (y_1 + y_2)$. It follows that $\frac{\partial n_{1t}}{\partial \lambda_t} = \frac{\partial n_{2t}}{\partial \lambda_t} < 0$. Then

$$\frac{\partial \Pi_{it}}{\partial \lambda_t} = w y_i \left(\frac{\partial n_{it}}{\partial \lambda_t} \right) < 0, \forall i = 1, 2 \quad (38)$$

Q.E.D.

Thus, an unforeseen shock that reduces the availability of reserves in the financial center is transmitted to the periphery when there is international financial integration (reserves-sharing) and a common international currency. The shock causes a reduction in (capital-based) output not only in the center but also in the periphery. In contrast, the owners of gold-reserves in both countries benefit from this kind of shock.

2.6 Policy

In the presence of a liquidity shock, the severity of the decline in output is directly related to the scarcity in the stock of reserves available for purchasing debt. However, liquidity shocks have these effects only when the liquidity constraint is operative. Moreover, the constraint on output is artificial in the sense that it is due only to a temporary lack of nominal liquidity that limits payments to factors of production (wages).

In this section, I discuss two possible policies: an elastic currency regime, and a policy of restrictive lending. In the first case, I focus on a discount window that may be operated by any of the monetary authorities⁸. In the second case, I discuss the incentives that the monetary authority in the financial center may have to impose limitations on the flows of financial capital.

2.6.1 An Elastic Currency Regime: a Discount Window

In this section, I demonstrate the potential benefits of appropriate discount window activity. Consider a discount window that is operated as follows. In the first stage of period $t+1$, the monetary authority lends fiat money⁹ at some chosen short-run (within-period) gross interest rate r_{t+1} to the old bankers who can demonstrate that they are using

⁸ For further discussion of alternative policies related to an elastic currency regime, see Freeman (1996 b), Freeman (forthcoming, 2002) and Green (1999).

⁹ The monetary authority could issue “gold certificates” instead, to be redeemed next period for money (gold). In this case, the gold certificates would be fully backed with gold by the monetary authority. For further discussion, see Freeman (1996 b).

the loan to purchase real bills (debt). When there is a common outside currency, the country where the debt was issued is irrelevant in the sense that all the debt is denominated in the same currency. An absence of arbitrage opportunities implies that

$$\frac{1}{q_{1,t+1}} = \frac{1}{q_{2,t+1}} = \frac{1}{q_{t+1}} = r_{t+1} \geq 1 \quad (39)$$

At the beginning of the second stage of the period, the old debtors arrive at their own country's central island to repay their debt to the old bankers. The old bankers are then able to repay the monetary authority's loan. Once the debt is repaid, the monetary authority can avoid inflationary pressures by removing from circulation the extra amount of fiat money lent to the old bankers. Notice that, if net transfers of fiat money across countries have occurred due to the implementation of this policy, some communication may be needed between the monetary authorities of both countries. Therefore, in this event, either the other country's monetary authority may directly remove the extra money from circulation or it may send the extra money to the other central island for its retirement.

It is important to note that, by choosing r_{t+1} , the monetary authority determines the extent to which the liquidity constraint is binding¹⁰. The lower r_{t+1} is, the weaker is the liquidity constraint at the world level. In the limit, when $r_{t+1}=1$, the debt is sold at par,

¹⁰ For an example of the implementation of this policy (in the absence of a central bank) in Canada during the period between 1880 and 1910, see Champ, Smith and Williamson (1996). They construct a model where seasonal variations in the demand for liquidity and credit play a central role in generating banking panics and argue that these panics do not occur if private banks can issue bank notes backed by general assets.

there is no liquidity constraint, and capital-based output cannot be increased further. Additionally, by setting $r_{t+1}=1$ the Golden Rule allocation is attained.

2.6.2 Restrictive Lending by the Financial Center

In this section, we show that a benevolent monetary authority in the financial center that cares only about its own residents has an incentive to implement capital controls. These incentives arise whenever the financial center is big enough: the center is not liquidity constrained in autarky¹¹ but the world economy is liquidity-constrained. In the remaining of this section, we assume that these conditions hold.

The monetary authority in the center can impose restrictions on the transfers of reserves as follows. This authority forces the old bankers born in the center to buy debt at par from the old capitalists born in the center. Once enough reserves have been used in the center to buy all available debt at par domestically, the old bankers born in the center are permitted to transfer the rest of their balances of gold to Country 1's central island, in which the debt is sold at a discount.

Events surrounding the crisis of 1836 provide an interesting example of the implementation of a policy of restrictive lending by a financial center. Early in that year, the Bank of England was losing specie reserves at a rapid rate and the Governor of the

¹¹ This is the case where $y_2 \geq (1 - \lambda_{t+1})$ for all possible values of λ_{t+1} .

Bank believed that the specie went to the United States¹². The Bank of England responded to the gold outflow not only by raising its discount rate, but also by imposing quantitative controls. More specifically, the Bank of England restricted its loans to United States by refusing to discount the bills of joint-stock banks or to handle acceptances of Anglo-American discount houses, even at the higher rates of interest¹³.

Why would the financial center's economic authority want to implement such a policy? The grounds for this policy may be found in its implications in terms of welfare. Once this policy is implemented, the financial center reaches an allocation that, for the center's capitalists and debtors replicates the Golden Rule, but that is superior to the Golden Rule, in welfare terms, for the center's bankers¹⁴. However, this welfare gain comes at the expense of some of the periphery's agents: the capitalists are worse-off relative to both the Golden Rule and the integrated equilibrium¹⁵, while the opposite is true for the owners of reserves (the bankers)¹⁶.

¹² The gold outflow that the Bank of England experienced in 1836 did not go to the United States, but it is not known where it went. See Temin (1969).

¹³ See Temin (1969)

¹⁴ Notice that, in the Golden Rule allocation, the bankers do not earn positive net profits. On the other hand, under a policy of restrictive lending by the financial center, the bankers born in this country earn positive net profits.

¹⁵ However, they are better-off relative to autarky.

¹⁶ The impact on the welfare of the periphery's debtors is ambiguous.

3 The Open Economy with Country-Specific Outside Currencies

In this section, I consider an environment similar to the one described in Section 2, but with two main differences: each country has its own outside currency and I allow the imposition of legal restrictions in the use of foreign exchange (foreign currency controls). Hence, Country 1's outside currency is called dollars, and we let $M_{1,0}$ be the nominal supply of dollars. Country 2's outside currency is called pounds, and $M_{2,0}$ denotes the supply of pounds. In addition, there is a legal restriction in Country i ($i=1,2$) by which all possible transactions in Country i must be performed and denominated using only Country i 's outside currency; no other currency can be used. The results can be easily extended to cases when there are different degrees of foreign currency controls¹⁷.

3.1 Trade and Travel Patterns

The trade and travel patterns, relative to the ones described in Section 2, are affected by the presence of country-specific currencies and a legal restriction in the use of foreign exchange as a means of payment. The timing of travels and transactions remains

¹⁷ For the case of complete absence of restrictions in the use of foreign currency, it is easy to show that there will be international financial integration. However, the Kareken and Wallace (1981) result -the indeterminacy of the exchange rate- will hold.

unchanged relative to the one described in Section 2. However, the nature of some of the transactions will be modified as is described below.

At the first stage of a period, when young debtors issue debt for the nominal value of the amount of the good they want to purchase, the presence of foreign currency controls restricts the denomination of the debt. Therefore, it matters if the debt issued in a given country is denominated in dollars or in pounds.

In addition, the legal restriction in both countries and free labor mobility imply that young workers may need to carry a currency different than the one circulating in the country they are working at. The need for a different currency arises from the fact that young workers working abroad must perform transactions in specific domestic locations the next period. Therefore, the operation of an exchange market is required for trading outside currencies. After supplying labor and exchanging currency, young workers go back to their own islands with the outside currency they earned working.

As before, a resale market for debt will open at the beginning of each period. However, the restrictions on the denomination of the debt along with restrictions on the use of foreign exchange determine that the old capitalists in a given central island accept only domestic currency in exchange for debt. This implies that both domestic and foreign old bankers must use only domestic currency to purchase debt. Thus, the operation of a foreign exchange market plays a crucial role in the sharing of reserves among countries.

At the beginning of the second stage of a period, the remaining debtors arrive at their own country's central island and repay their debt to the old bankers using their own

country's outside currency. Next, all the old agents go back to their own islands and the competitive labor markets open.

Finally, notice that the operation of a foreign exchange market is needed twice within a period. The first one relates to the operation of the international market for gold reserves at the beginning of the period. The second corresponds to the operation of the international labor market, during the second part of the period.

3.2 Equilibrium and Optimality

In equilibrium, the young capitalists born in Country 1 accept the debt offered to them only if it is a promise of receiving dollars next period, since they must purchase labor using only dollars. Similarly, the young capitalists born in Country 2 only accept debt that promises them pounds next period. Thus, due to the presence of full foreign currency controls in both countries, in equilibrium Country 1's debt is dollar-denominated and Country 2's debt is pound-denominated.

On the other hand, young workers born in Country 1 (Country 2) work only for dollars (pounds), regardless of their location: the debtors must repay their debt using dollars (pounds) while the bankers must use dollars (pounds) to purchase labor.

By Proposition 2, the old bankers born in Country 2 have an incentive to take reserves to Country 1's central island. However, they must previously exchange their

pounds for dollars (Country 1's old capitalists accept only dollars). Unfortunately, because of the combination of the lack of synchronicity (at the heart of the financial crises discussed in this paper) and the legal restrictions on the means of payments to be used in both countries, at this time there are no agents in Country 1 –the only dollar-holders- that will sell dollars for pounds. Therefore, no trade occurs in the exchange market at this stage¹⁸, leading to financial autarky: Country 2's old bankers are not able to take reserves to the financial periphery and there is no reserve-sharing. In addition, for the same reason, there is no trade in the exchange market when it opens again at the second stage of this period either, precluding also labor mobility across countries.

Thus, in the environment described, the presence of full foreign currency controls in a world of country-specific currencies leads to a lack of trade in the exchange markets. The latter precludes financial integration, preventing the operation of a market of reserves: the countries cannot share reserves anymore and country-specific reserves (the autarkic situation) displace international reserves. This equilibrium is the autarkic (closed economy) situation for both countries.

Moreover, in this autarkic equilibrium, the resale price of the debt will not be equal across countries. In addition, due to the short supply of reserves in at least one of the countries, the debt will not be always sold at par in equilibrium. This causes a difference in the marginal rates of substitution across countries. Therefore, from

¹⁸ Due to the presence of foreign currency controls, the (shadow) exchange rate will be determined in the market. However, no one will trade at that exchange rate. For extensions of this case to similar environments, see Fujiki (2000).

Proposition 3, the autarkic equilibrium allocation does not maximize the steady-state utility for the world economy.

3.3 Liquidity Shocks and Output

This section discusses the effects, in a (stochastic) steady-state equilibrium with financial autarky, of changes in the needs for liquid reserves on both output and the profits earned by the reserves-holding sector. Due to the absence of financial integration, the results in this section will differ from the ones discussed in Section 2.5. Once again, the analysis focuses on the consequences of innovations in λ_t , which represent unforeseen and unpredictable changes in the availability of reserves in the financial center at time t .

The proofs for Propositions 6 and 7 follow directly from the proofs of Propositions 4 and 5 and are not included here.

Proposition 6. *In the liquidity-constrained equilibrium with no financial integration, when there are country-specific outside currencies and full foreign currency controls, innovations in the needs for liquidity in the financial center (reductions in λ_t) do not affect output or gross nominal profits in the financial periphery.*

Proposition 7. *In the liquidity-constrained equilibrium with no financial integration, when there are country-specific outside currencies and full foreign currency controls,*

innovations in the needs for liquidity in the financial center (reductions in λ_t) will reduce (capital-based) output but will increase gross nominal profits in the financial center.

Thus, an unforeseen shock that reduces the availability of reserves in the financial center is confined to the financial center in the absence of reserves-sharing, when there are country-specific outside currencies and full foreign currency controls. The shock causes a reduction in (capital-based) output only in the center, while the owners of gold-reserves in the center benefit from this kind of shock.

4 Financial Crises under the International Gold Standard

This section presents the experiences of the United Kingdom and the United States in two distinct periods: the Antebellum period (before 1862) and the Greenback period (1862-1879).

The United Kingdom resumed gold convertibility in 1821 –after the Napoleonic wars- while the United States established a de facto gold standard in 1834. The United Kingdom remained continuously on gold until 1914, but the United States was off gold for a period of seventeen years -known as the Greenback period (1862-1879). Also, during the International Gold Standard, the United States grew gradually in importance in the world financial markets and, by the early 20th century, it became the new world's financial center¹⁹.

Therefore, during both the Antebellum period and the Greenback period, the United Kingdom was still the world's financial center. In addition, in both periods there were crises in which the origin of the business contractions was a drain of specie-reserves in the United Kingdom, followed by a reaction of the Bank of England. However, each period was characterized by different international monetary regimes: during the Antebellum period both countries were on gold, while during the Greenback period only one country (the United Kingdom) was on gold.

¹⁹ For a general reference to the history of this period, see Huffman and Lothian (1984), Martin (1968 and 1973), Temin (1969) and Timberlake (1961).

As shown in Tables 1a and 1b, the Antebellum crises share the following main stylized facts: a drain of specie reserve in the United Kingdom was followed by (or coincident with) a business contraction there and a reaction by the Bank of England (either an increase in discount rates or quantitative controls or both). The immediate effect was gold inflows from the United States to the United Kingdom, which caused a contraction in the specie stock and a financial crisis in the United States due to the lack of means of payments. The latter was followed by or coincident with a business contraction in the United States, which, in most of the cases, was more severe than the one in the United Kingdom. Hence, when both countries were on gold, it is noticeable that the liquidity problems (scarcity of specie as means of payments) were transmitted from the financial center (where they originated) to the financial periphery, with the subsequent transmission of the associated business contractions. The model presented in Section 2 of this paper is consistent with these facts. In that environment, unforeseen shocks that reduce the availability of reserves in the financial center are transmitted to the periphery when there is reserves-sharing and a common outside currency. This shock causes reductions in output both in the center and the periphery.

On the other hand, as shown in Tables 2a and 2b, the events during the business contraction that originated in the United Kingdom in 1866 -during the Greenback period- were remarkably different. The origin of the contraction was a drain of specie reserves in the Bank of England, followed by a sharp increase in the British discount rates. However, the monetary and business contraction that followed in the United Kingdom did not

spread to the United States. The model presented in Section 3 of this paper is consistent with these facts. In that environment, the effects of liquidity shocks are confined to the financial center in the absence of reserve-sharing, when there are country-specific outside currencies and full foreign currency controls.

5 Conclusions

This paper presents an environment in which common outside currencies and the absence of legal restrictions on foreign exchange use may help a financial periphery to (fully or partially) overcome nominal constraints on output by allowing the sharing of reserves with a large financial center. However, financial integration also allows the transmission of liquidity shocks from the financial center to the periphery with consequences for real activity. Moreover, the analysis is consistent with the historical observations on financial crises in the United Kingdom and the United States during the Antebellum period. During this period, when both countries were on gold, we do observe that monetary and business contractions spread from the United Kingdom (the financial center) to the United States (the periphery). During these crises, the financial center will have incentives to implement a policy of restricting flows of specie. The events observed during the crisis of 1836 –during the Antebellum period- provide an example of the implementation of this kind of policy. An alternative to foreign financial dependence for the financial periphery is the development of its own central banking: the provision of the nominal means of payment needed via an elastic currency regime. The latter would be consistent with attainment of the Golden Rule when full liquidity is provided (that is: when the reserves are not in short supply).

On the other hand, the presence of full foreign currency controls in a world of country-specific currencies leads to an absence of trade in the exchange markets. This

precludes financial integration and prevents the operation of a global market for reserves. The resulting equilibrium is autarkic. Such an environment replicates observations from the business contraction of 1866 (during the Greenback period), when the United States was off of gold. In the financial crisis of 1866, the monetary and business contraction that originated in the United Kingdom was confined to the United Kingdom.

Chapter III

Private Information and Inflation Targeting in Small Open Economies^{***}

Abstract

I investigate the relative merits of a policy of inflation targeting with floating exchange rates in a small open economy. I compare this policy to a (free) floating exchange rate regime and to a currency board along the following dimensions: the successful achievement of low and stable inflation rates, the promotion of financial deepening, and the avoidance of stagnation in output.

I model an economy that reproduces several aspects of several Latin American economies during the 1990s. Financial intermediaries perform a real allocative function in the presence of multiple reserve requirements and an adverse selection problem in credit markets. The severity of this friction in credit markets is endogenous and, financial intermediaries may need to ration credit in order to induce self-selection. There are no legal restrictions regarding the use of foreign currency or investment abroad.

Under a policy of inflation targeting, steady state equilibria replicate the equilibria under a (free) floating exchange rate regime. Thus, the ability to raise the domestic rate of inflation above the foreign rate of inflation can increase output if credit is rationed.

^{***} I thank Scott Freeman and Bruce D. Smith very specially.

However, the presence of inflation thresholds determines that there is a strict limit to the extent to which inflation can be used to promote domestic activity.

The scope for economic fluctuations can typically be reduced by a policy of inflation targeting, when compared to either a (free) floating exchange rate regime or a currency board. However, the potential of this policy to improve on stability and/or on the determinacy of dynamic equilibria seems to depend strongly on the probability of repaying loans in the economy.

JEL classification: E31, E32, E42, E44, F31, F33, G14, G18, O16

Keywords: Currency Board; Fixed exchange rate regime; Floating exchange rates; Growth; Indeterminacy; Inflation; Inflation targeting; Multiple Reserve Requirements; Private Information; Stabilization

1 Introduction

An exchange rate regime is defined by a particular choice and financing of monetary targets. Volatility, on the other hand, reflects the presence of endogenous economic fluctuations. Can different exchange rate regimes have identical steady-state equilibria but, at the same time, have very particular characteristics in terms of stability and vulnerability to volatility? This paper attempts to answer this question.

The study of alternative methods of achieving price stability, in the context of an open economy, is intimately related to the issue of the relative merits of alternative exchange rate regimes. In the past decade, economies open to international capital flows³ have been -and still are- in the process of moving away from adjustable pegs (e.g. crawling pegs), some toward harder pegs (e.g., currency boards or arrangements with no separate legal tender), but more towards systems with greater exchange rate flexibility. Among the Latin American countries classified as emerging market economies, Argentina and, more recently, Ecuador have had very hard pegs while, on the other extreme of the spectrum, Brazil, Chile, Colombia and Perú have independent floats; Venezuela seems to be the only country with an intermediate peg⁴. Many of the recent converts have opted for an inflation-targeting approach⁵. Moreover, inflation targeting serves as monetary policy framework in several advanced economies⁶.

³ Mostly, economies classified as developed markets and emerging markets by the IMF. See Fisher (2001).

⁴ See Fisher (2001).

⁵ See Fisher (2001).

⁶ See Masson, Savastano and Sharma (1997) and Croce and Khan (2000).

The evidence seems to suggest that the relative merits of alternative exchange rate regimes is still an open issue, especially when the key role of financial market frictions is considered⁷. However, the analysis of alternative ways of conducting monetary policy with floating exchange rates (i.e., “how to float”) when important financial market frictions are present seems to be equally important. In particular, inflation targeting seems to be a promising alternative⁸.

Inflation targeting can be defined as a framework for conducting monetary policy that commits the central bank to achieving low inflation. Masson, Savastano and Sharma (1997) identified two prerequisites for a successful inflation targeting framework: first, the ability to carry out a substantially independent monetary policy, especially one not constrained by fiscal considerations; second, the freedom from commitment to another nominal anchor like the exchange rate or wages. Given the context of independent central banks as well as the long histories of high inflation rates in most Latin American countries⁹, these countries constitute an interesting environment where to study the results of implementing such a policy.

In this paper I examine a small open economy where a floating exchange rate regime operates together with a policy of inflation targeting. In particular, I compare the relative merits of a policy inflation targeting to the merits of two alternative policies studied in Chapter I: a policy of (free) floating exchange rates and alternative policies of

⁷ See, for example, Chang and Velasco (2000a, 2000b) and Fisher (2001).

⁸ Chang and Velasco (2000a), Croce and Khan (2000), Fisher (2001).

⁹ See Chang and Velasco (2000a)

fixed exchange rates. I do so in the specific context analyzed in Chapter I: a small open economy where financial intermediaries perform a real allocative function in the presence of an adverse selection problem in credit markets *à la* Azariadis and Smith (1996). Interestingly, the severity of the friction in the credit markets is endogenous and financial intermediaries may need to ration credit in order to induce self-selection¹⁰. Moreover, as shown in Chapter I, the rate of inflation will have a strong effect on the extent to which credit is rationed and, thus, on financial depth. Again, I incorporate several features to the model that are particularly relevant to Latin American experiences during the 1990s. In particular, a domestic and a foreign currency circulate in the domestic economy, and domestic lending is subject to multiple reserve requirements that are, in general, binding. In addition, there are no legal restrictions either on the use of foreign currency or on investing abroad.

In this context, I consider the following policy: the monetary authority exogenously¹¹ sets a target for the domestic inflation rate once and for all. Every period, the monetary authority injects (withdraws) as much domestic currency as needed, so that the target is met. On the other hand, the nominal exchange rate is market determined¹².

I find that changes in domestic inflation and world (U.S. inflation) affect the domestic capital stock differently according to whether credit is rationed or not. In

¹⁰ Credit rationing is often argued to be a very important aspect of funds allocation in developing economies.

¹¹ In this paper, I do not address explicitly the issue of how this target is chosen. However, the results of the analysis will, hopefully, shed some light on what should be considered when choosing the target.

¹² Notice that, given its internal design and the nature of the environment, the policy that I discuss is credible, sustainable and implemented by an independent monetary authority.

addition, either credit rationing tends to be observed when domestic rates of inflation are low, or else the scope for credit to be rationed depends in a relatively complicated way on the target for domestic inflation. The first situation will emerge when the probability of repaying a loan is relatively high while the second will arise when the probability of repayment is sufficiently low. Moreover, steady-state equilibria under a policy of floating exchange rates with inflation targeting are identical to the corresponding equilibria under a (free) floating exchange rate regime¹³.

In situations where the probability of repaying loans is high, moderate increases in the inflation target (which, of course, is equal to the inflation rate) stimulate output and lead to financial deepening when credit is rationed (inflation is initially low), but reduce output and financial depth when there is no credit rationing (inflation is initially high). Thus, just as under an ordinary floating exchange rate regime¹⁴, there will be inflation thresholds as observed empirically¹⁵. Inflation and output are positively (negatively) correlated below (above) the threshold. When equilibrium dynamics are considered, I find that –when credit is rationed– either dynamic equilibria are indeterminate and endogenously arising volatility will be observed in all the endogenous variables but the inflation rate, or dynamic equilibria are determinate, displaying monotonic convergence. In situations where the first case arises, a policy of inflation targeting seems to increase the scope for indeterminacy but to reduce the potential for economic fluctuations, relative

¹³ Of course, whenever the target for inflation, under the first policy, is equal to the rate of domestic money creation, under the second policy.

¹⁴ See Chapter I.

¹⁵ See Bullard and Keating (1995) or Khan and Senhadji (2000).

to an ordinary (free) floating exchange rate regime. However, when the second situation arises, a policy of inflation targeting seems to reduce the scope for both instability and economic fluctuations relative, again, to a policy of (free) floating exchange rates. Finally, when compared to a currency board, a policy of inflation targeting seems to typically reduce the potential for endogenously arising economic fluctuations.

On the other hand, in situations where the probability of repaying loans is low and there is a policy of inflation targeting, increases in the domestic inflation always have adverse consequences for the level of real activity in the long-run. Again in this case, steady-state equilibria replicate the corresponding equilibria under a (free) floating exchange rate regime (with an appropriately selected rate of money creation). With respect to equilibrium dynamics, I find that –when credit is rationed– dynamic equilibria are indeterminate, but no economic fluctuations are observed. Thus, when compared to either a policy of (free) floating exchange rates or a currency board, a policy of inflation targeting seems typically to reduce the scope for economic fluctuations.

The remainder of the paper is organized as follows. In Section 2, I present the environment. This economy shares the main stylized characteristics of the Peruvian and Argentinean economies after their stabilizations¹⁶, as well as of several other Latin American economies. Next, in Section 3, I consider the conditions for a general equilibrium under a policy of inflation targeting. In Section 4, I describe steady state equilibria, as well as the conditions under which credit rationing may be observed, while

¹⁶ And, of course, before the Argentinean crisis.

in Section 5 I describe equilibrium dynamics. Finally, in Section 6 I present the main conclusions of the analysis.

2 The Environment

In this section, I build a model of a small open economy that captures the main stylized characteristics that are particularly relevant to several Latin American experiences during the 1990s. The environment is identical to the one presented in Chapter I, where I analyze the relative merits of (free) floating versus fixed exchange rates. I consider, then, a small open economy consisting of an infinite sequence of two-period lived, overlapping generations. Again, time is discrete and indexed by $t=0, 1, 2, \dots$. In each generation there is a continuum of agents with unit mass. Agents can be of two types: Type 1 agents comprise a fraction $\lambda \in (0,1)$ of the population, while the remaining fraction $(1-\lambda)$ consists of Type 2 agents.

A single tradable final good is produced every period, using both physical capital and labor. K units of physical capital and N units of labor produce $F(K, N)$ units of the final good, where $F(\cdot)$ is a constant returns to scale production function. Let $f(k) \equiv F(k, 1)$ denote the intensive production function, with k being the capital-labor ratio, $k \equiv K/N$. I assume that $f(\cdot)$ is a smooth, increasing, concave function such that $f(0) = 0$. Finally, I also assume, without real loss of generality, that capital depreciates completely in the production process.

All agents are risk neutral and, for simplicity, care about consumption of the final good only in the final period of life. There is no disutility from labor.

2.1 Endowments

Type 1 agents and Type 2 agents will differ, among other things, in their endowments. Type 1 agents are “natural” lenders: they are endowed with one unit of labor when young (which they supply inelastically) but they have no labor endowment when old. On the other hand, Type 2 agents are “natural” borrowers: they are endowed with one unit of labor when old (which they supply inelastically) but they have no endowment of labor when young.

There are two technologies available in the economy for transferring resources between periods, and different agent types will have different access to them. One of these technologies is a pure storage technology whereby one unit of the good stored at t returns $x > 0$ units of consumption at $t+1$. x should be thought of as relatively small, so that the storage technology is not efficient. Only young Type 1 agents have access to this storage technology.

The second technology, an investment technology, transforms one unit of the final good at t into one unit of physical capital at $t+1$. Young Type 1 agents have access to this technology with probability $\pi \in (0,1)$. However, with probability $(1-\pi)$ investments in this technology will produce nothing for Type 1 agents. If capital is received when old, a Type 1 agent making an investment can then hire young labor, and produce final goods using the commonly available final goods production technology. For simplicity I assume that only agents who receive capital from previous investments can utilize this

technology; there are no rental markets in physical capital. On the other hand, young Type 2 agents have access to the investment technology with certainty. Once physical capital is obtained, old Type 2 agents can combine their own labor with labor they hire from young Type 1 agents, and they can then produce the final good. Again, purely for simplicity, old Type 2 agents are assumed to work only for themselves.

In addition to young agents, there is an initial old generation at $t=0$. These agents are all endowed with one unit of labor and $K_0 > 0$ units of physical capital. No other agents have an initial endowment of capital, nor are any agents endowed with the final good.

2.2 Informational Structure

At the beginning of each period, each agent knows his own type. However, the agent's type is private information. Since Type 2 agents are natural borrowers, having access to a productive investment technology but no young period income, this private information gives rise to a conventional adverse selection problem in credit markets.

In addition, if they obtain credit, at some point each young Type 1 agent learns whether or not he can productively invest in physical capital. This information is also private to the agent. However, age and all market transactions (like working, making

deposits in or borrowing from the financial system) are observable. The activity of storing goods does not require market transactions, and, therefore, storage activity is unobservable.

Given the structure of information, young Type 2 agents cannot credibly claim to be of Type 1 and supply labor when young. However, young Type 1 agents can credibly claim to be of Type 2. In order to do so, young Type 1 agents must borrow the same amount that young Type 2 agents do and they cannot supply labor. However, only a fraction π of Type 1 agents have the ability to create physical capital. The remaining fraction cannot operate the production process when old and they would then be discovered as having misrepresented their type. I assume that they can be punished prohibitively. Consequently, the fraction $(1-\pi)$ of young Type 1 agents who obtain credit will avoid punishment only if they “abscond” with their loan. They can do so by taking any credit received when young, investing in the storage technology, and “going underground” when old¹⁷. The agents both escape punishment, and avoid repaying their loan. Finally, notice that Type 2 agents have no access to the storage technology and, consequently, they choose never to abscond.

¹⁷ x could also be regarded as representing the punishment incurred after misrepresenting one's type and taking an unproductive loan.

2.3 Trading and Financial Intermediation

There are several types of trades that can take place in this economy. First, old producers can hire labor from young Type 1 agents at the competitive real wage, w_t . Second, Type 1 agents who work when young save all their labor income, and part of their savings can be lent to domestic agents claiming to be of Type 2. I will think of domestic lending as being intermediated.

There is free entry into the domestic activity of intermediation. I let R_t denote the gross real interest rate offered on deposits by domestic financial intermediaries between t and $t+1$, and ρ_t the gross interest rate charged on loans made at t and maturing at $t+1$. Third, young Type 1 agents can also invest their savings abroad¹⁸. One unit of goods invested abroad at t returns $r > 1$ goods at $t+1$, where r is the gross international real interest rate. Of course the assumption that the domestic economy is small implies that no events in the domestic economy influence r . Also notice that the storage technology being inefficient implies that $R_t > x$ and $r > x$.

In addition, two types of currency circulate in the domestic economy. One is issued by the domestic government. Let M_t be the outstanding stock of domestic currency at t and p_t denote the domestic price level. In addition, foreign currency may circulate in the domestic economy. I let Q_t denote the outstanding stock of foreign currency in the domestic country, while p_t^* denotes the price level in the rest of the world. I also let e_t

¹⁸ Such investments could also be thought of as cross-border deposits. See Baliño, Benner and Borensztein (1999).

denote the market determined nominal exchange rate at t , defined as units of domestic currency required to purchase a unit of foreign currency at t . The law of one price implies that $e_t p_t^* = p_t$, for all t .

All domestic lending is subject to the financial regulations of the domestic country. It is assumed that all agents lending domestically must hold currency reserves. Some of these reserves must be held in domestic, and some in foreign currency. Let $\phi_d \in (0,1)$ denote the fraction of deposits that must be held in the form of domestic currency. Domestic currency reserves held from t to $t+1$ earn the gross real return $\left(\frac{p_t}{p_{t+1}} \right)$. Similarly, let $\phi_f \in (0,1)$ denote the fraction of deposits that must be held in the form of foreign currency reserves by lenders. Foreign currency reserves held between t and $t+1$ earn the gross real return $\left(\frac{e_{t+1} p_t}{e_t p_{t+1}} \right)$. Obviously it will be assumed that $\phi_d + \phi_f < 1$. Finally, I will focus on the situation where both reserves requirements are binding. This will transpire if $\left(\frac{p_t}{p_{t+1}} \right) < r$ and $\left(\frac{e_{t+1} p_t}{e_t p_{t+1}} \right) < r$ both hold, so that (net) nominal rates of interest are positive both domestically, and in the rest of the world. Clearly, in contexts like Latin America, the assumption of binding reserve requirements is a highly relevant one.

2.3.1 Credit Markets

In keeping with standard practice in the literature on adverse selection (Rothschild and Stiglitz, 1976; Azariadis and Smith, 1996), I seek a separating equilibrium in credit markets. In particular, I seek an equilibrium where only Type 2 agents obtain credit. This approach is similar than the one I used in Chapter I.

Let b_t denote the real value of borrowing by young agents claiming to be of Type 2 at t ¹⁹. I assume free entry into intermediation, which implies that domestic intermediaries earn zero profits in equilibrium. This requires that the gross real loan rate, ρ_t , satisfy

$$\rho_t = \frac{\left[R_t - \phi_d \left(\frac{p_t}{p_{t+1}} \right) - \phi_f \left(\frac{e_{t+1} p_t}{e_t p_{t+1}} \right) \right]}{(1 - \phi_d - \phi_f)} \quad (1)$$

Equation (1) asserts that the weighted average of a lender's returns on loans, domestic currency reserves, and foreign currency reserves must equal the gross real rate of interest on deposits.

¹⁹ Young Type 1 agents do not borrow if their Type is known as long as $\rho_t \geq \text{Max}\{R_t, r, x\}$. This condition will hold in equilibrium.

2.4 Agents' Behavior and Factor Markets

Type 2 agents cannot store goods and they do not wish to consume when young. In addition, let τ_t denote the real (goods) value of a lump-sum transfer received from the government by young agents claiming to be of Type 2²⁰. (As in Chapter I, this can be regarded as an investment subsidy.) Therefore, they invest in physical capital all the resources they obtain in youth, and each old Type 2 agent at $t+1$ will have a capital stock equal to

$$K_{t+1} = b_t + \tau_t \quad (2)$$

reflecting both credit received and the government investment subsidy. In addition, at $t+1$, Type 2 agents combine their inherited capital stock with their own unit of labor, plus L_{t+1} units of young Type 1 labor. Finally, these agents repay their loans. Therefore, after some derivations²¹ and noting that $k_{t+1} = w^{-1}(w_{t+1}) \equiv \Psi(w_{t+1})$, the consumption of an old Type 2 agent born at t , $c_{2,t+1}$, can be written as

$$c_{2,t+1} = \{f'[\Psi(w_{t+1})] - \rho_t\}b_t + w_{t+1} + f'[\Psi(w_{t+1})]\tau_t \quad (3)$$

Notice that Type 2 agents will be willing to take loans only if

$$f'[\Psi(w_{t+1})] = f'(k_{t+1}) \geq \rho_t \quad (4)$$

²⁰ The sources of financing of this transfer will become clear once we explain the government policy. At this point, we do not need more explanation given that this transfer is perceived as lump-sum by the agents.

²¹ See Chapter I for the derivations.

2.5 Loan Contracts

In a similar way to that in Chapter I, in equilibrium, lenders must design loan contracts that channel funds to natural borrowers. Therefore the loan contracts offered, in equilibrium, must prevent Type 1 agents from misrepresenting their type (since it is unprofitable to lend to these agents). Thus loan contracts must induce self-selection²². As derived in Chapter I, competition among lenders implies that contractual loan terms, ρ_t and b_t , must be chosen to maximize the expected utility (consumption) of Type 2 agents, subject to the zero profit condition (1) and the self-selection constraint given by

$$R_t d_t + r t_t^* \geq \pi \{ [f'(\Psi(w_{t+1})) - \rho_t] b_t + f'(\Psi(w_{t+1})) \tau_t \} + (1 - \pi) x(b_t + \tau_t). \quad (5)$$

That is, (ρ_t, b_t) maximizes $c_{2,t+1}$, subject to (1) and (5), taking $\tau_t, w_{t+1}, R_t, p_t, p_{t+1}, p_t^*$ and p_{t+1}^* as given.

As I have already noted, this problem has a nontrivial solution if and only if (4) is satisfied. If (4) is an equality, then Type 2 agents are indifferent about the loan quantity they receive. In equilibrium, loan quantities must simply be such that marginal product of capital equals the loan rate. This outcome is what would be expected in the absence of private information. In effect, the adverse selection problem is non-binding. I refer to this as a Walrasian outcome. Alternatively, if (4) holds as a strict inequality, then Type 2 agents would like to borrow arbitrarily large amounts. Of course, excessive lending

²² As in Chapter I, see Rothschild and Stiglitz (1976) -or, in a more closely related environment, Azariadis and Smith (1996)- for a proof that the only nontrivial equilibrium in this economy induces agents to self-select.

would violate the self-selection constraint. Hence Type 2 agents experience credit rationing, and the loan quantity b_t is determined by the self-selection constraint (5) at equality. In the next section, I describe when both Walrasian and Credit Rationed equilibria emerge as outcomes.

3 A General Equilibrium and Government Policy

There are several conditions that must be satisfied in a full general equilibrium. First, in the absence of any restrictions on international goods trade, the purchasing power parity condition

$$p_t = e_t p_t^* \quad (6)$$

must hold. In addition, with no restrictions on international capital flows, rates of return on investments must be equated both internationally and domestically. Hence,

$$R_t = r. \quad (7)$$

I assume throughout that $r > x$, so that goods storage is inefficient. In addition, I focus throughout on situations where the reserve requirements bind. Thus

$$r > \left(\frac{p_t}{p_{t+1}} \right) \quad (8)$$

and

$$r > \left(\frac{p_t^*}{p_{t+1}^*} \right) \quad (9)$$

both hold. Recall that d_t denotes the per capita quantity of deposits held by banks lending domestically. Then, since both reserve requirements bind, it follows that

$$\frac{M_t}{p_t} = \phi_d \lambda d_t \quad (10)$$

and

$$\frac{e_t Q_t}{p_t} = \phi_f \lambda d_t \quad (11)$$

(since a fraction λ of domestic agents are of Type 1, and hence are savers).

Additionally, the market for loans clears if the supply of deposits less bank reserves equals the demand for loans. This condition obtains if

$$(1 - \phi_d - \phi_f) \lambda d_t = (1 - \lambda) b_t. \quad (12)$$

Finally, let i_t^* to be the real value of net investment abroad, per young Type 1 agent. Then

$$i_t^* = w(k_t) - d_t \quad (13)$$

(that is, net investment abroad equals domestic savings less domestic deposits).

In credit markets, four conditions must be satisfied in equilibrium. First, banks earn zero profits so that (1) holds. Second, (4) must hold. Third, the self-selection constraint (5) must be satisfied. Fourth, an absence of arbitrage opportunities requires that $R_t = r$.

3.1 Government Policy

Using (10), I can write the rate of domestic inflation as

$$\frac{p_t}{p_{t-1}} = \left(\frac{M_t}{M_{t-1}} \right)^{\left(\frac{d_{t-1}}{d_t} \right)} \quad (14)$$

However, under a policy of inflation targeting, the monetary authority sets a target for the domestic inflation rate and withdraws/injects domestic currency accordingly in order to fulfill this target, given the state variables $\{d_{t-1}, d_t\}$ at time t . Let σ denote the target net domestic inflation rate, constant $\forall t$. Then,

$$\frac{p_t}{p_{t-1}} = (1 + \sigma). \quad (15)$$

Combining (14) with (15) and solving for the supply of domestic currency at t , I obtain

$$M_t = (1 + \sigma) M_{t-1} \left(\frac{d_t}{d_{t-1}} \right) \quad (16)$$

Finally, the government budget constraint -along with the condition that self-selection occurs in the credit market- implies that

$$(1 - \lambda) \tau_t = \frac{(M_t - M_{t-1})}{p_t}. \quad (17)$$

The fiscal policy described by (17) has two important features. First, because the lump-sum transfers are given to young agents claiming to be of Type 2, this policy does not affect capital formation *per se* in a full-information environment (Walrasian environment). However, it does affect the self-selection constraint and thus capital formation when credit is rationed. Therefore, considering different ways of redistributing

the lump-sum transfers might lead to different results. For example, we might want to give equal transfers to all the young agents, independently of their type, or to give lump-sum transfers to young agents of Type 1 as well as to agents of Type 2 in a way that the self-selection constraint is not affected. In the first case, the self-selection constraint is still affected by the lump-sum transfer. In the second case, the required policy seems to be a highly sophisticated one to implement and would not be credible. I illustrate both alternatives in Appendix C.

Second, in this paper I assume that the monetary authority cannot credibly hold a reserve position to “back” the money supply. The case that I consider in this paper seems to be relevant for most of the Latin American economies with floating exchange rates, but it could be extended to allow for a reserve position. This paper does not consider this extension.

3.2 Equilibrium Conditions

It is possible to express the main equilibrium conditions compactly as

$$f'(k_{t+1}) \geq \rho_t = \frac{\left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \phi_f \left(\frac{p_t^*}{p_{t+1}^*} \right) \right]}{(1 - \phi_d - \phi_f)}, \quad (18)$$

$$r(1-\lambda)w(k_t) \geq \left[\pi f'(k_{t+1}) + [(1-\pi)x - \pi\rho_t] \right] k_{t+1} + \pi\rho(1-\lambda)\tau_t, \quad (19)$$

$$\tau_t = G_1 \frac{k_{t+1}}{(1-\lambda)} - G_2 \frac{k_t}{(1-\lambda)} + G_2 \tau_{t-1} \quad (20)$$

and

$$i_t^* = w(k_t) - \left[\frac{k_{t+1} - (1-\lambda)\tau_t}{\lambda(1-\phi_d - \phi_f)} \right], \quad (21)$$

where

$$G_1 \equiv \frac{\phi_d}{(1-\phi_f)} \quad \text{and} \quad G_2 \equiv \frac{\phi_d}{(1+\sigma)(1-\phi_f)}. \quad (22)$$

Equation (18) says that the marginal product of capital must weakly exceed the interest rate on loans for Type 2 agents to be willing to take loans. Equation (19) is the self-selection constraint in credit markets. Equation (20) is the government budget constraint and equation (21) is the aggregate resource constraint. Note that one of the conditions (18) or (19) must hold as an equality. If (18) holds as an equality, the equilibrium is Walrasian. If (19) holds as an equality, credit is rationed.

As in Chapter I, in order to obtain sharp characterizations of equilibria with and without credit rationing, it is convenient to assume that the production function has the Cobb-Douglas form $f'(k) = Ak^\alpha, \alpha \in (0,1)$. In addition, for simplicity, I also assume that the rest of the world has a constant rate of inflation equal to its constant (net) rate of money creation, σ^* . Thus,

$$\frac{p_t^*}{p_{t+1}^*} = \frac{1}{(1+\sigma^*)} < r, \quad \forall t. \quad (23)$$

Notice that (23) together with the policy of inflation targeting imply that the interest rate on loans is a constant given by

$$\rho_t = \rho = \frac{\left[r - \left(\frac{\phi_d}{1 + \sigma} \right) - \left(\frac{\phi_f}{1 + \sigma^*} \right) \right]}{(1 - \phi_d - \phi_f)}, \quad \forall t. \quad (24)$$

Under these assumptions, I proceed to the analysis of steady-state equilibria. The analysis of dynamic equilibria will be taken up in Section 5.

4 Steady-State Equilibria

Steady-state equilibria will be characterized by allocations in which the triplet $\{k, \tau, i^*\}$ is constant. I now analyze Walrasian and Credit Rationing regimes separately.

4.1 Steady-State Equilibria in a Walrasian Regime

In this section I derive the conditions necessary to show that Walrasian outcomes with a policy of inflation targeting have the same steady-state properties as Walrasian outcomes with (free) floating exchange rates.

A steady-state Walrasian equilibrium has $f'(k) = \rho$, and the self-selection constraint (19) does not bind. Let $\hat{k}$, $\hat{\tau}$, and $\hat{i}^*$ denote, respectively, the steady-state capital-labor ratio, investment subsidy, and net investment abroad in a Walrasian regime. (18) allows us to determine $\hat{k}$

$$\hat{k} = \left[\frac{\alpha A}{\rho} \right]^{\frac{1}{1-\alpha}} = \left\{ \frac{\left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]^{\frac{1}{\alpha-1}}}{\alpha A (1 - \phi_d - \phi_f)} \right\}. \quad (25)$$

In addition, using (20) it is possible to determine $\hat{\tau}$

$$\hat{\tau} = (1 - \varepsilon) \hat{k}, \quad (26)$$

where ε is defined by

$$\varepsilon \equiv \frac{b}{K} = \frac{(1+\sigma)(1-\phi_d - \phi_f)}{[(1-\phi_d - \phi_f) + \sigma(1-\phi_f)]}. \quad (27)$$

Notice that positive lending and borrowing together with binding reserve requirements imply that $\sigma > \text{Max}\left\{\sigma_\varepsilon, \left(\frac{1}{r} - 1\right)\right\}$ must hold, where $\sigma > \sigma_\varepsilon$ implies that $\varepsilon > 0$. Notice that under these conditions, it is always the case that $\rho > 0$.

(21) determines $\hat{i}^*$. Substituting (26) into (21), I obtain

$$\hat{i}^* = (1-\alpha)A\hat{k}^\alpha - \frac{\varepsilon\hat{k}}{\lambda(1-\phi_d - \phi_f)}. \quad (28)$$

At this point it is useful to define the total fraction of savings invested abroad (denoted by $\hat{\chi}$) as an additional variable of interest. It is clear that $\hat{\chi}$ is given by

$$\hat{\chi} \equiv \frac{\hat{i}^*}{w(\hat{k})} = 1 - \frac{\varepsilon\hat{k}^{1-\alpha}}{\lambda A(1-\alpha)(1-\phi_d - \phi_f)}. \quad (29)$$

Notice that equations (25), (28) and (29) are identical to, respectively, equations (36), (37) and (38) in Chapter I. Thus, it is possible to infer that steady-state equilibria in a Walrasian regime with a policy of inflation targeting are identical to the corresponding equilibria under (free) floating exchange rates²³. Moreover, Propositions 1 to 3 in Chapter I still hold under a policy of inflation targeting and the intuition remains unchanged. I reproduce these Propositions below.

²³ And, of course, with an appropriately selected rate of money growth.

Proposition 1. *In a Walrasian steady-state, an increase in the rate of domestic inflation (σ) reduces the capital-labor ratio ($\hat{k}$), reversing the Mundell-Tobin effect. In addition, the ratio of investment abroad to total savings in a stationary Walrasian allocation ($\hat{\chi}$) is increasing in the steady-state domestic inflation rate.*

Proposition 2. *An increase in either the steady-state rate of inflation in the rest of the world (σ^*) or the international interest rate on deposits (r) reduces the capital-labor ratio ($\hat{k}$) and increases the ratio of investment abroad to total savings ($\hat{\chi}$) in a Walrasian steady-state equilibrium.*

Proposition 3. *An increase in either the domestic currency reserve requirement (ϕ_d) or the foreign currency reserve requirement (ϕ_f) reduces the capital-labor ratio ($\hat{k}$) in a Walrasian steady-state.*

The intuition is as follows: an increase in either the domestic or the foreign rate of inflation lowers the return that domestic financial intermediaries receive on their currency reserves. As a result, the rate of interest on loans must increase in order for domestic banks to compete for deposits in world markets. Therefore, when the private information problem does not bind, higher inflation rates, by increasing the real interest rate on loans, lead to a reduction in domestic capital investment.

With respect to the welfare implications of higher inflation rates, natural lenders (Type 1 agents) are always worse-off with higher inflation rates, either domestic or foreign, because, by increasing the real interest rate on loans, they reduce the domestic

capital stock, which reduces then the natural lenders' labor income. On the other hand, a higher domestic inflation rate will have an ambiguous effect on the welfare of the natural borrowers (Type 2): with a higher domestic inflation, the real interest rate on loans increases and this would reduce welfare; but at the same time higher domestic inflation increases the subsidy rate received by Type 2 agents, increasing, thus, welfare. Finally, a higher world inflation rate does not affect the subsidy rate received by Type 2 agents but it increases the real interest rate on loans, reducing in this way the natural borrowers' welfare.

4.2 Steady-State Equilibria with Credit Rationing

In this section, I derive the conditions necessary to show that credit-rationing outcomes with a policy of inflation targeting have the same steady-state properties as credit-rationing outcomes with (free) floating exchange rates.

A steady-state equilibrium with Credit Rationing has $f'(k) > \rho$ and the self-selection constraint (19) binds. Let $\tilde{k}$, $\tilde{\tau}$ and $\tilde{\chi}$ denote, respectively, the steady-state capital-labor ratio, investment subsidy and ratio of investment abroad to savings in a Credit Rationing regime. When credit is rationed in a steady-state equilibrium, (19) will determine the capital-labor ratio:

$$\tilde{k} = \left\{ \frac{[(1-\pi)\chi - \pi\epsilon\rho]}{A[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\}^{\frac{1}{\alpha-1}} \quad (30)$$

while (20) will determine $\tilde{\tau}$:

$$\tilde{\tau} = (1-\epsilon) \frac{\tilde{k}}{(1-\lambda)} \quad (31)$$

and (21) will determine $\tilde{\chi}$:

$$\tilde{\chi} \equiv \frac{\tilde{i}^*}{w(\tilde{k})} = 1 - \left[\frac{\epsilon \tilde{k}^{1-\alpha}}{\lambda(1-\alpha)A(1-\phi_d - \phi_f)} \right], \quad (32)$$

where $\tilde{i}^*$ denotes investment abroad in a steady-state equilibrium with Credit Rationing.

Notice that equations (30) and (32) are identical, respectively, to equations (39) and (40) in Chapter I. Thus, it is possible to infer that steady-state equilibria in a Credit

Rationing regime with a policy of inflation targeting are identical to the corresponding equilibria under (free) floating exchange rates. Moreover, Propositions 4 to 6 in Chapter I still hold under a policy of inflation targeting and the intuition remains unchanged. I reproduce these Propositions below.

Proposition 4. *Suppose that*

$$r(1-\lambda)(1-\alpha) < (>) \alpha\pi \quad (33)$$

holds²⁴. Then an increase in the domestic rate of inflation increases (reduces) the steady-state capital-labor ratio $\tilde{k}$. If an increase in the domestic inflation rate reduces $\tilde{k}$, then the same increase necessarily increases the fraction of savings invested abroad ($\tilde{\chi}$).

Proposition 5. *Suppose that $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ holds. Then an increase in the foreign inflation rate (σ^*) or the world real interest rate (r) reduces (increases) the domestic capital-labor ratio $\tilde{k}$. These same changes increase (reduce) the ratio of savings done abroad ($\tilde{\chi}$).*

Proposition 6. *Suppose that $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ holds. Then an increase in the required reserves held in domestic currency (ϕ_d) reduces (increases) the capital-labor ratio ($\tilde{k}$). On the other hand, an increase in the required reserves held in foreign*

²⁴ Of course if $r(1-\lambda)(1-\alpha) > (<) \alpha\pi$, $(1-\pi)x > (<) \varepsilon\rho$ must hold in order for $f'(\tilde{k})$ to be well-defined.

currency (ϕ_f) reduces (increases) the capital-labor ratio ($\tilde{k}$) if $\sigma > \left\{ \frac{\sigma^* \phi_d}{[r(1 + \sigma^*) - 1]} - 1 \right\}$

but increases (reduces) $\tilde{k}$ if $\sigma < \left\{ \frac{\sigma^* \phi_d}{[r(1 + \sigma^*) - 1]} - 1 \right\}$.

The fact that Propositions 4 to 6 still hold implies that the same important points that were true for steady state-equilibria under a (free) floating exchange rate regime are also true under a policy of inflation targeting. First, when credit is rationed, increases in the domestic inflation rate and in the world inflation rate will affect the domestic capital stock differently. This is the case because the self-selection constraint (19) is affected differently by changes in domestic and foreign inflation. However, in a Walrasian equilibrium, changes in the domestic and foreign inflation have qualitatively similar effects.

Second, it is also the case that changes in the domestic rate of inflation can have very different effects under credit rationing than they do in a Walrasian equilibrium. Once again, this happens because what matters is how the self-selection constraint is affected by changes in the domestic rate of inflation. Higher domestic inflation can relax the self-selection constraint by increasing the interest rate on loans and, in this way, reducing the incentives of Type 1 agents to misrepresent their type. Whether or not higher rates of domestic inflation have this effect depends on the probability of a Type 1 agent actually repaying a loan if it is taken (i.e., it depends on the magnitude of π).

With respect to the welfare implications of higher inflation rates when credit is rationed, notice that because domestic and foreign inflation affect the self-selection constraint differently, they will also affect domestic agents differently. When Case 1 obtains, higher domestic inflation increases the real interest rate on loans and the subsidy rate, relaxing the self-selection constraint and leading, in this way, to a higher domestic capital stock when credit is rationed and Case 1 obtains. A higher domestic capital stock will reflect on a higher labor income for natural lenders (Type 1 agents), resulting in higher welfare for these agents. However, the natural borrowers (Type 2 agents) will be better-off only under very special conditions because there are two forces working in opposite directions: higher domestic inflation increases output and the subsidy rate, implying higher welfare for natural borrowers; but a higher domestic inflation rate also increases the real interest rate on loans, resulting in lower welfare for these agents²⁵. On the other hand, higher world inflation rates increase only the real interest rate on loans (the subsidy rate remains unchanged), leading to a lower domestic capital stock. A lower capital stock will reflect on a lower labor income for natural lenders (Type 1 agents), resulting in a lower welfare for these agents. However, Type 2 agents will also be adversely affected by higher foreign inflation only under very special conditions because there are two forces working in opposite directions: a higher world inflation rate reduces output and, therefore, it also reduces welfare for the natural borrowers; at the same time,

²⁵ It can be shown that, when Case 1 obtains, natural borrowers will be better-off with a higher domestic inflation rate if and only if $A\{\alpha\pi[(1-\lambda)(1-\alpha)+1]-r((1-\lambda)(1-\alpha))^2\}>\varepsilon\rho\pi\tilde{k}^{1-\alpha}$.

even though the real interest rate on loans is higher, the total amount that has to be repaid could be reduced because of the lower capital stock²⁶.

Notice that also because domestic inflation has the opposite effects on the domestic capital stock in Walrasian outcomes than it does under credit rationing, the effects of higher domestic inflation on the natural borrowers' welfare in Walrasian outcomes are also reversed under credit rationing, when Case 1 obtains. However, a higher world inflation rate always leads to a lower domestic capital stock, either with credit rationing or in Walrasian outcomes. Thus higher world inflation always reduces the natural lenders' welfare when Case 1 obtains.

²⁶ It can be shown that, when Case 1 obtains, natural borrowers will be worse-off with a higher world inflation rate if and only if $A\{\alpha\pi[(1-\lambda)(1-\alpha)+1]-r((1-\lambda)(1-\alpha)^2\}>\varepsilon\rho\pi\tilde{k}^{1-\alpha}$.

4.3 When Does Credit Rationing Occur?

In this section I describe when credit rationing does and does not occur, in a steady-state equilibrium. As noted in the previous sections, steady-state equilibria under a policy of (free) floating exchange rates -described in Chapter I- are identical to steady-state equilibria under a policy of inflation targeting. Therefore, it will also be the case that whether or not credit rationing is observed depends on things like the domestic and foreign inflation rates, and on the world real interest rate.

Notice again that steady-state equilibria do (not) display credit rationing if $f'(k) > (=)\rho$. Thus, I now describe when $f'(k) > \rho$ holds. The following lemma will prove useful.

Lemma 7. *The steady-state interest rate on loans is a monotonically increasing and concave function of the steady-state domestic inflation rate, for any*

$\sigma > \text{Max}\left\{\left(\frac{1}{r} - 1\right), \sigma_\epsilon\right\}$, *and it is bounded above.*

Notice that Lemma 7 is identical to Lemma 7 in Chapter I. Therefore, if $\rho(\sigma)$ denotes the loan rate as a function of σ , Lemma 7 implies that $\rho(\sigma)$ has the configuration depicted in Figures 1 and 2.

When credit rationing can emerge now depends on assumptions on parameter values. I describe two cases.

Case 1: $\alpha\pi > r(1-\lambda)(1-\alpha)$. When Case 1 obtains, $f'(\tilde{k})$ is a monotonically decreasing function of σ . Moreover, as $\varepsilon\rho$ grows smaller and closer to $\left(\frac{1-\pi}{\pi}\right)_x$, $f'(\tilde{k})$ decreases and, typically, converges to a small and positive number. Thus we have the situation depicted in Figure 1. Credit is rationed iff $\sigma < \sigma_c$ holds.

When Case 1 obtains, if the initial domestic rate of inflation is fairly low, increases in the domestic rate of inflation (that is, increases in σ) can be used to stimulate capital formation and long-run output²⁷. However, there is a strict limit to the extent to which domestic inflation can be used for this purpose. Once $\sigma > \sigma_c$, the equilibrium will be Walrasian, and further increases in the domestic money growth rate will have adverse consequences for long-run real activity²⁸. Thus there will be inflation thresholds, as is observed empirically.

Case 2: $\alpha\pi < r(1-\lambda)(1-\alpha)$. In a Case 2 economy, $f'(\tilde{k})$ can be shown to be an increasing, concave function of σ . As a result, several possibilities arise regarding the existence of steady states where credit is rationed. The possibilities are illustrated by Figures 2a, 2b, and 2c.

²⁷ This is consistent with evidence reported by Bullard and Keating (1995) and Khan and Senhadji (2000) that, at low rates of inflation, moderate increases in the rate of inflation can increase the long-run level of real activity.

²⁸ This is consistent with evidence that, at high enough rates of inflation, further increases in inflation have detrimental effects on the level of long-run activity. Again, see Bullard and Keating (1995) or Khan and Senhadji (2000).

Figure 2a. For high (low) values of the domestic inflation rate, credit is (is not) rationed.

This situation tends to transpire when x is relative large.

Figure 2b. For rates of money creation below σ_L or for rates of money creation above σ_H , credit is not rationed. Credit is rationed iff $\sigma \in (\sigma_L, \sigma_H)$.

Figure 2c. $\rho(\sigma)$ lies everywhere above $f'(\tilde{k})$. This situation tends to arise when x is relatively small.

Notice that, in a Case 2 economy, the scope for credit to be rationed may depend in a relatively complicated way on the rate of inflation. In particular, the “bindingness” of informational asymmetries need not depend monotonically on the target rate of inflation.

Finally, notice that, because of the fact that steady-state equilibria under a policy of inflation targeting are identical to steady-state equilibria under a policy of (free) floating exchange rates, it is not surprising that the conditions under which credit rationing occurs are also similar between these two policies.

5 Dynamic Equilibria

5.1 Dynamic System in a Walrasian Regime

The dynamic system in a Walrasian regime is given by (18) with equality, (20) and (21). In addition, (19) holds as an inequality. Notice that (19) with equality implies that the capital-labor ratio is always at the steady-state level $\hat{k}$. Therefore, the dynamic system in a Walrasian regime can be rewritten as

$$k_{t+1} = \hat{k}, \quad \forall t, \quad (34)$$

$$\tau_t = (G_1 - G_2) \frac{\hat{k}}{(1 - \lambda)} + G_2 \tau_{t-1}, \quad (35)$$

$$i_t^* = \left[(1 - \alpha) A \hat{k}^\alpha - \frac{\hat{k}}{\lambda(1 - \phi_d - \phi_f)} \right] + \frac{(1 - \lambda) \tau_t}{\lambda(1 - \phi_d - \phi_f)}, \quad (36)$$

and

$$r(1 - \lambda)(1 - \alpha) A \hat{k}^\alpha > (1 - \pi) \chi \hat{k} + \pi(1 - \lambda) \rho \tau_t \quad (37)$$

Notice that (34), (35) and (36) constitutes a recursive dynamic system: the capital-labor ratio is always at the steady-state level and (35) governs the dynamics of the government's fiscal position. Equation (36) then indicates how the net investment abroad inherits its dynamics from the dynamics of the government's fiscal position.

5.1.1 Local Stability Analysis

Equation (35) is a first order linear difference equation. The dynamic properties of τ_t will depend on G_2 . Using (22) it is easy to determine that $0 < G_2 < 1$, $\forall \sigma > \text{Max} \left\{ \left(\frac{1}{r} - 1 \right) \sigma_\varepsilon \right\}$.

Therefore, the government's fiscal position is stable and dynamic paths approaching the steady-state do so monotonically. Notice also, from (36), that cross-border capital flows will display monotonic dynamics too.

How does this compare with the exchange rate regimes analyzed in Chapter I? In the first place, recall that when credit was not rationed and there were (free) floating exchange rates, the economy was able to attain the steady-state after one period. Thus, a policy of inflation targeting seems to increase the scope for instability when compared with a policy of (free) floating exchange rates. On the other hand, note that when credit was not rationed and a currency board was in place, fluctuations in the value of the investment subsidy could be observed. Thus, a policy of inflation targeting seems to eliminate the potential for fluctuations that was observed under a currency board.

5.2 Dynamic System in a Credit Rationing Regime

The dynamic system under credit rationing is given by

$$r(1-\lambda)(1-\alpha)Ak_t^\alpha = \alpha\pi Ak_{t+1}^\alpha + [(1-\pi)x - \pi\rho]k_{t+1} + \pi(1-\lambda)\rho\tau_t, \quad (38)$$

equation (20),

$$i_t^* = (1-\alpha)Ak_t^\alpha - \left[\frac{k_{t+1} - (1-\lambda)\tau_t}{\lambda(1-\phi_d - \phi_f)} \right], \quad (39)$$

and

$$\alpha k_{t+1}^{\alpha-1} > \rho. \quad (40)$$

Equations (38) and (20) jointly govern the dynamics of the capital-labor ratio and the government's fiscal position. Equation (39) then describes the dynamics of net investment abroad.

Rearranging terms in (38) and (20), and defining $q_t = \tau_{t-1}$, I obtain the following dynamic system:

$$k_{t+1} = \left(\frac{G_2}{G_1} \right) k_t + \frac{(1-\lambda)}{G_1} \tau_t - (1-\lambda) \left(\frac{G_2}{G_1} \right) q_t = l(k_t, \tau_t, q_t) \quad (41)$$

$$\begin{aligned} \tau_{t+1} = & \left[\frac{r(1-\alpha)A}{\pi\rho} \right] k_{t+1}^\alpha - \left[\frac{\alpha A}{(1-\lambda)\rho} \right] [l(k_{t+1}, \tau_{t+1}, q_{t+1})]^\alpha \\ & - \left[\frac{(1-\pi)x - \pi\rho}{\pi(1-\lambda)\rho} \right] l(k_{t+1}, \tau_{t+1}, q_{t+1}) \end{aligned} \quad (42)$$

$$q_{t+1} = \tau_t \quad (43)$$

5.2.1 Local Stability Analysis

I now linearize the dynamic system (41), (42) and (43) in a neighborhood of the nontrivial steady state. The Jacobian of the linearized system is

$$J(\tilde{k}, \tilde{\tau}, \tilde{q}) = \begin{bmatrix} l_1 & l_2 & l_3 \\ l_1 \left(\frac{P}{R} \right) & \left(\frac{S}{R} \right) & l_3 \left(\frac{P}{R} \right) \\ 0 & 1 & 0 \end{bmatrix}, \quad (44)$$

where

$$l_1 \equiv \left(\frac{G_2}{G_1} \right), \quad l_2 \equiv \frac{(1-\lambda)}{G_1}, \quad l_3 \equiv -(1-\lambda) \left(\frac{G_2}{G_1} \right) \quad (45)$$

$$P \equiv \left\{ r(1-\lambda)(1-\alpha) f'(\tilde{k}) - l_1 \left[\alpha \pi f'(\tilde{k}) + (1-\pi)x - \pi \rho \right] \right\} \quad (46)$$

$$R \equiv \left\{ \pi(1-\lambda)\rho + l_2 \left[\alpha \pi f'(\tilde{k}) + (1-\pi)x - \pi \rho \right] \right\} \quad (47)$$

and

$$S \equiv r(1-\lambda)(1-\alpha) l_2 f'(\tilde{k}) - (l_1 l_2 + l_3) \left[\alpha \pi f'(\tilde{k}) + (1-\pi)x - \pi \rho \right] \quad (48)$$

It is easy to show that the determinant of $J(\tilde{k}, \tilde{\tau}, \tilde{q})$ is equal to zero. Therefore, one of the eigenvalues of J will be equal to zero. Let

$$H_1 \equiv \left(\frac{S}{R} \right) + l_1 \quad (49)$$

and

$$H_2 \equiv (l_1 l_2 + l_3) \left(\frac{P}{R} \right) - l_1 \left(\frac{S}{R} \right) \quad (50)$$

Thus, the remaining two eigenvalues are given by the roots η of the following quadratic equation:

$$\eta^2 - H_1\eta - H_2 = 0. \quad (51)$$

Let

$$a(\sigma) \equiv [(1 + \sigma)r(1 - \lambda)(1 - \alpha)(1 - \phi_f) + \alpha\pi\phi_d] \quad (52)$$

and

$$b(\sigma) \equiv [\alpha\pi(1 - \phi_f)f'(\tilde{k})] + [(1 - \phi_f)(1 - \pi)x - (1 - \phi_d - \phi_f)\pi\rho] \quad (53)$$

It can be shown that

$$H_1 \equiv \left(\frac{S}{R}\right) + l_1 = \frac{a(\sigma)f'(\tilde{k}) + \phi_d(1 - \pi)x}{(1 + \sigma)b(\sigma)} \quad (54)$$

and

$$H_2 \equiv (l_1l_2 + l_3)\left(\frac{P}{R}\right) - l_1\left(\frac{S}{R}\right) = -\frac{\phi_d r(1 - \lambda)(1 - \alpha)f'(\tilde{k})}{(1 + \sigma)b(\sigma)}. \quad (55)$$

The properties of dynamic equilibria near the nontrivial steady state when credit is rationed may differ according to whether a Case 1 economy or a Case 2 economy is being considered. Therefore, different parameter configurations²⁹ may imply that dynamic equilibria have different properties. Specifically, notice that it is always the case that $a(\sigma) > 0$ and that $[(1 - \phi_f)(1 - \pi)x - (1 - \phi_d - \phi_f)\pi\rho]$ is decreasing in σ , but the properties of $b(\sigma)$

²⁹ Specifically, different magnitudes of π , the probability of a Type 1 agent actually repaying a loan if it is taken.

may differ according to whether Case 1 or Case 2 arises. In what follows I describe the dynamic properties of the system when Case 1 or Case 2 obtains, respectively.

Case 1: $\alpha\pi > r(1-\lambda)(1-\alpha)$. When Case 1 obtains, it must be the case that $[(1-\phi_f)(1-\pi)x - (1-\phi_d-\phi_f)\pi\rho] < 0$, in order for $f'(\tilde{k})$ to be well defined. In addition, recall from Proposition 4 that $f'(\tilde{k})$ is decreasing in σ . Thus, $b(\sigma)$ is a decreasing function of σ in a Case 1 economy. I am able to determine, analytically, that three cases may arise. I will present numerical examples of each of these cases³⁰.

Case 1.1: $b(\sigma) > 0, \forall \sigma > \sigma_\varepsilon$. In these numerical examples³¹, $\forall \sigma > \sigma_\varepsilon$, the nontrivial steady-state is a saddle with positive eigenvalues. Therefore, dynamic equilibria are determinate and no fluctuations are observed along the stable manifold. Moreover, the stable eigenvalue is decreasing in σ .

Case 1.2: Let $\bar{\sigma}$ to be such that $b(\bar{\sigma}) = 0$. It is possible to observe that $b(\sigma) > 0$, if $\sigma \in (\sigma_\varepsilon, \bar{\sigma})$ and $b(\sigma) < 0$ if $\sigma > \bar{\sigma}$. In these numerical examples³², for low values of σ , i.e., $\sigma \in (\sigma_\varepsilon, \bar{\sigma})$, the nontrivial steady-state is a saddle with positive

³⁰ The following parameters were kept constant both for Case 1 and for Case 2: $r=1.1$, $x=1$, $\sigma^*=0.05$ and $\alpha=0.35$. In order to represent Case 1, I used $\pi=0.95$, while for a Case 2 I chose $\pi=0.05$. Finally, for each one of the possibilities considered, I do consider an economy with reserve requirements similar to the Peruvian economy (i.e. $\phi_d=0.02279$ and $\phi_f=0.33615$) as well as an economy with reserve requirements similar to the Argentinean economy (i.e., $\phi_d=\phi_f=0.085$). Therefore, I consider, in total, twelve scenarios: six scenarios correspond to Case 1 (i.e. 3 for each Perú and Argentina) and the remaining six correspond to Case 2 (i.e. 3 for each Perú and Argentina).

³¹ For Case 1.1, I used $\lambda=0.6$.

³² For Case 1.2, I used $\lambda=0.7$.

eigenvalues. Thus, dynamic equilibria are determinate and no fluctuations are observed along the stable manifold. Again, the stable eigenvalue is decreasing in σ .

For high values of σ , i.e., for $\sigma > \bar{\sigma}$, the nontrivial steady-state is still a saddle, but the eigenvalues have opposite signs. However, the stable eigenvalue is positive and no fluctuations will be observed along the stable manifold. Again, the stable eigenvalue is decreasing in σ .

Case 1.3: $b(\sigma) < 0, \forall \sigma > \sigma_\varepsilon$ In these numerical examples³³, the nontrivial steady-state is a sink and the eigenvalues have opposite signs. As a consequence, dynamic equilibria are indeterminate and fluctuations can be observed. Therefore, in this case endogenously arising volatility will be present in the economy.

Case 2: $\alpha\pi < r(1 - \lambda)(1 - \alpha)$. In a Case 2 economy, it must be the case that $[(1 - \phi_f)(1 - \pi)x - (1 - \phi_d - \phi_f)\pi\rho] > 0$, in order for $f'(\tilde{k})$ to be well defined. In addition, recall from Proposition 4 that $f'(\tilde{k})$ is increasing in σ . Thus, it is always the case that $b(\sigma) > 0$ in a Case 2 economy³⁴. Moreover, the nontrivial steady-state is always a sink with positive

³³ For Case 1.3, I used $\lambda=0.85$. It might be interesting to notice that it seems to be the case that $\alpha\pi - r(1 - \lambda)(1 + \alpha) > 0$ when $b(\sigma) < 0, \forall \sigma > \sigma_\varepsilon$.

³⁴ Relative to the numerical examples, even though $b(\sigma) > 0, \forall \sigma > \sigma_\varepsilon$, I still consider 6 scenarios in total, that mirror the scenarios contemplated for a Case 1 economy: $\lambda = \{0.6, 0.7, 0.85\}$, and for each of the values of λ considered, I analyze the Argentinean economy as well as the Peruvian economy. It might be also interesting to notice that it is always the case that $\alpha\pi - r(1 - \lambda)(1 + \alpha) < 0$.

eigenvalues. Therefore, dynamic equilibria are indeterminate and no fluctuations will be observed.

6 Conclusions

This paper presents a model of a small open economy that shares several characteristics of most of the Latin American economies during the 1990s. In this economy, financial intermediaries perform a real allocative function in the presence of multiple (and binding) reserve requirements and an adverse selection problem in credit markets. The severity of this friction in the credit markets is endogenous and, thus, financial intermediaries may or may not need to ration credit in order to induce self-selection. Moreover, the rate of inflation has a very strong effect on the extent to which credit is rationed, and therefore, the ability of the monetary authority to achieve low and stable inflation is of the utmost importance. I then consider the relative merits of a policy of inflation targeting with floating exchange rates. I compare this policy to a (free) floating exchange rate regime as well as to a currency board in the following dimensions: the successful achievement of low and stable inflation rates, the promotion of financial deepening and the ability to avoid stagnation in output.

I find that changes in domestic inflation and world (U.S. inflation) affect the domestic capital stock differently according to whether credit is rationed or not. What matters when credit is rationed is how the domestic and world rates of inflation affect the self-selection constraint, and they affect this differently. In addition, either credit rationing tends to be observed when domestic rates of inflation are low, or else the scope for credit to be rationed depends in a relatively complicated way on the target for

domestic inflation. The first situation will emerge when the probability of repaying a loan for a disassembling Type I agent is relatively high while the second will arise when the probability of repayment is sufficiently low. Moreover, steady-state equilibria under a policy of floating exchange rates with inflation targeting are identical to the corresponding equilibria under a (free) floating exchange rate regime (with an appropriately chosen rate of money growth), whether credit is rationed or not.

In situations where the probability of repaying loans is high, moderate increases in the inflation target (which, of course, is equal to the inflation rate) stimulate output and lead to financial deepening when credit is rationed (inflation is initially low), but reduce output and financial depth when there is no credit rationing (inflation is initially high). Thus, there will be inflation thresholds as observed empirically^{35 36}: inflation and output are positively (negatively) correlated below (above) the threshold. As a result, domestic inflation can be used to stimulate output –which cannot be done under a fixed exchange rate regime, because domestic and foreign inflation must be equal-, but there is a strict limit to this ability due to the presence of the inflation threshold. When equilibrium dynamics are considered, I find that –when credit is rationed- either dynamic equilibria are indeterminate and endogenously arising volatility will be observed in all the endogenous variables but the inflation rate, or dynamic equilibria are determinate, displaying monotonic convergence. In situations where the first case arises, a policy of inflation targeting seems to increase the scope for indeterminacy but to reduce the

³⁵ See Bullard and Keating (1995) or Khan and Senhadji (2000).

³⁶ See Chapter I.

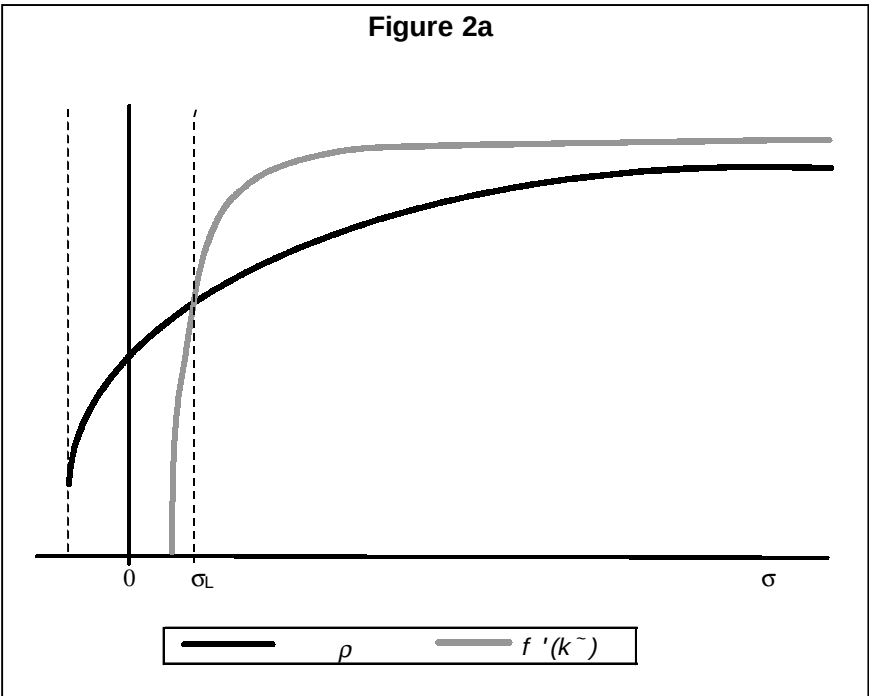
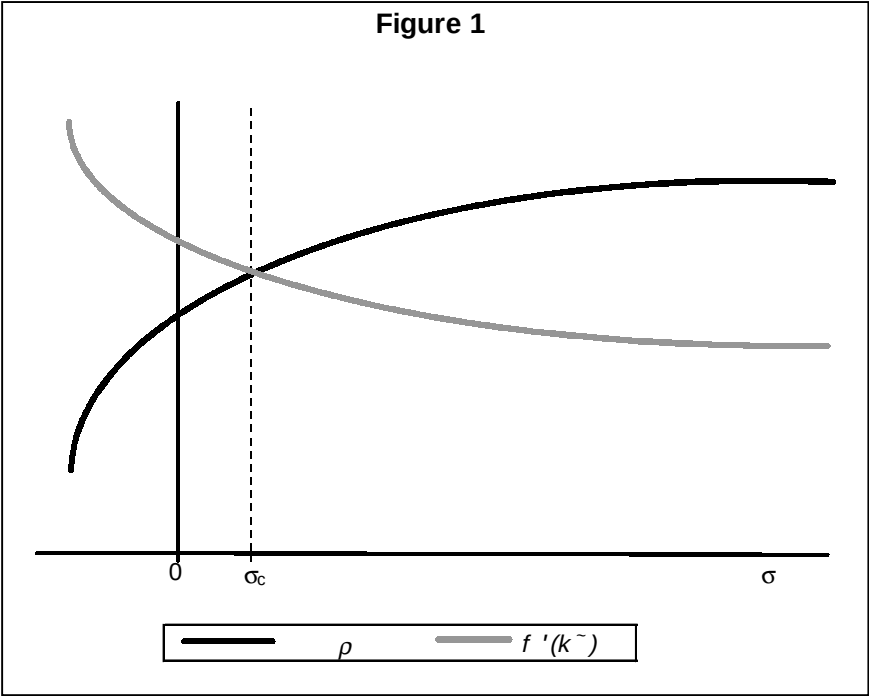
potential for economic fluctuations, relative to a (free) floating exchange rate regime. However, when the second situation arises, a policy of inflation targeting seems to reduce the scope for both instability and economic fluctuations relative, again, to a policy of (free) floating exchange rates. Finally, when compared to a currency board, a policy of inflation targeting seems to typically reduce the potential for economic fluctuations.

On the other hand, in situations where the probability of repaying loans is low and there is a policy of inflation targeting, increases in the domestic inflation always have adverse consequences for the level of real activity in the long-run. Again in this case, steady-state equilibria replicate the corresponding equilibria under a (free) floating exchange rate regime. With respect to equilibrium dynamics, I find that –when credit is rationed- dynamic equilibria are indeterminate, but no economic fluctuations are observed. When compared to either a policy of (free) floating exchange rates or a currency board, a policy of inflation targeting seems to typically reduce the scope for economic fluctuations.

It is then possible to argue that, for a small open economy like the one presented in this paper, a policy of inflation targeting will typically reduce the scope for economic fluctuations, when compared to either a (free) floating exchange rate regime or a currency board. However, the potential of this policy to improve on the stability and/or determinacy of dynamic equilibria seems to depend strongly on one the fundamentals of this economy: the probability of repaying loans. Future research would attempt to build a link between this probability and the information that may be regularly available to a

policy maker, like, for example, the states of the economy. This might also offer some additional guidance for the task of choosing the target for domestic inflation.

Figures



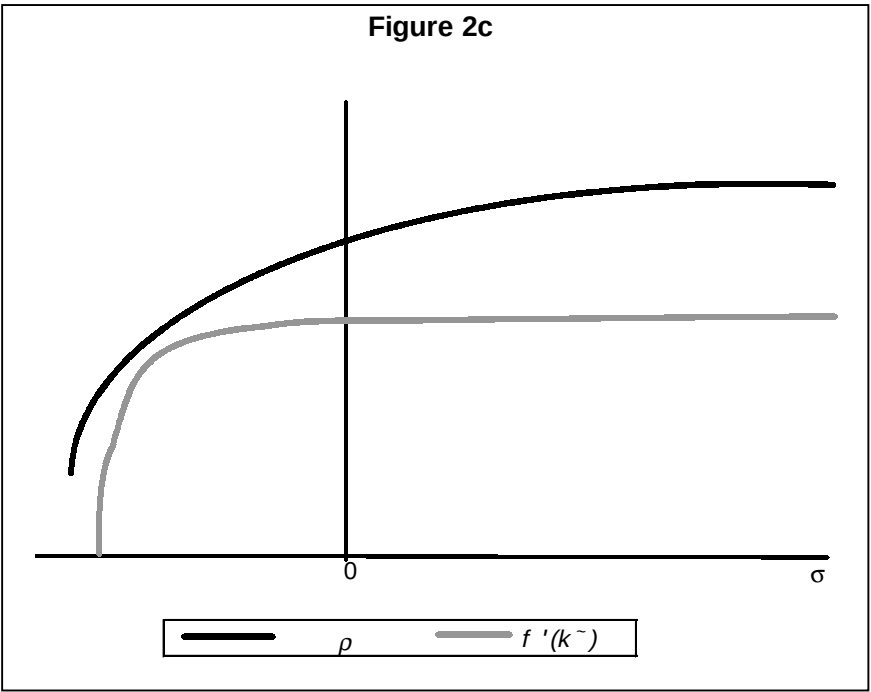
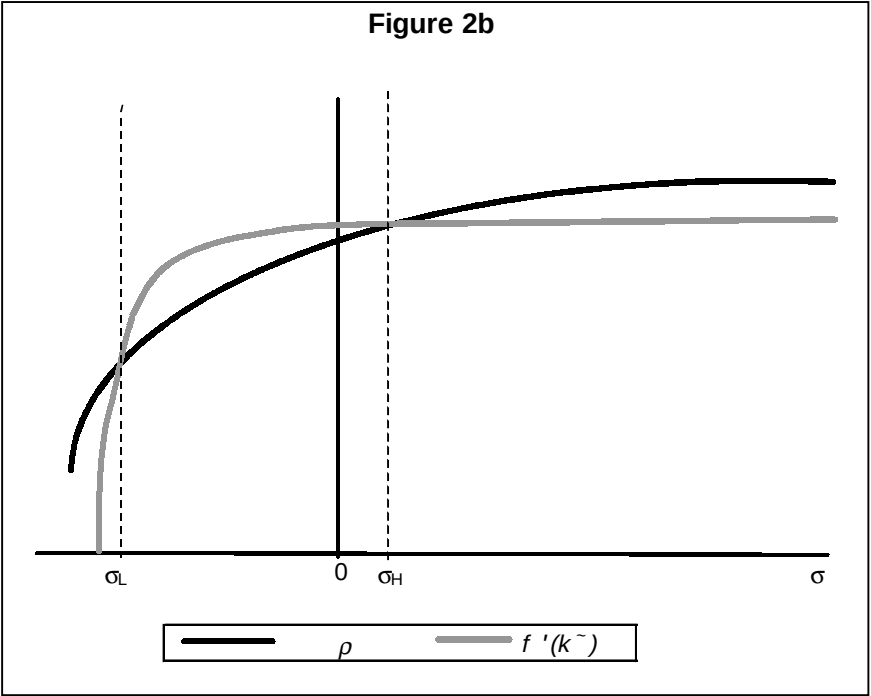


Figure 3
Perú: Equilibrium Law of Motion for the
Capital-Labor Ratio in a Walrasian Regime

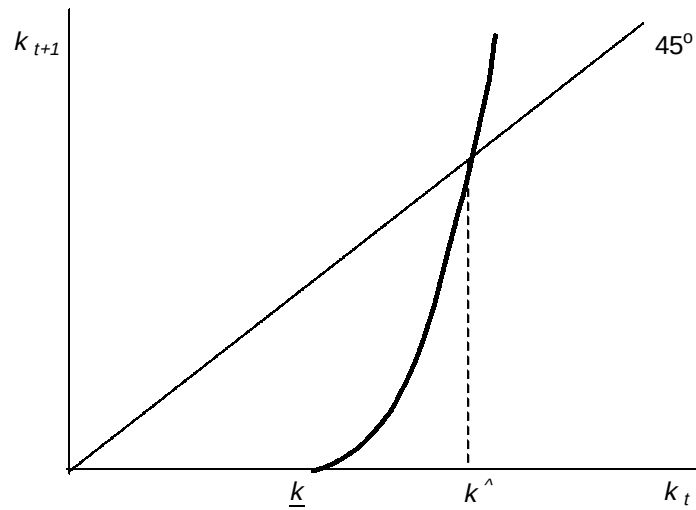


Figure 4
Perú: Phase Diagram
in a Credit Rationing Regime

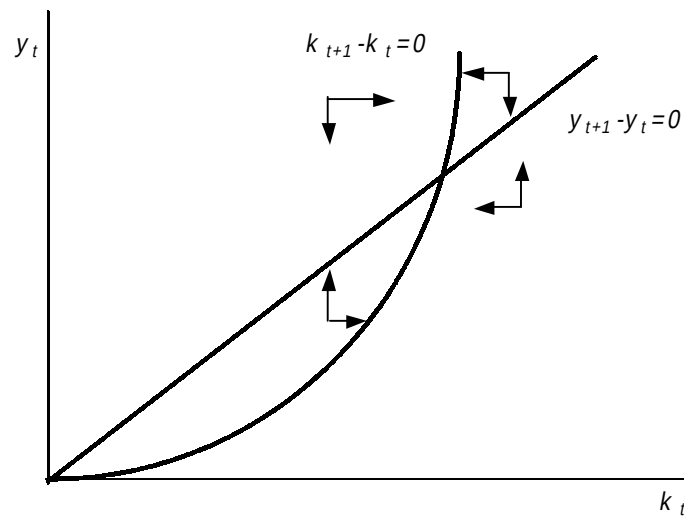


Figure 5a

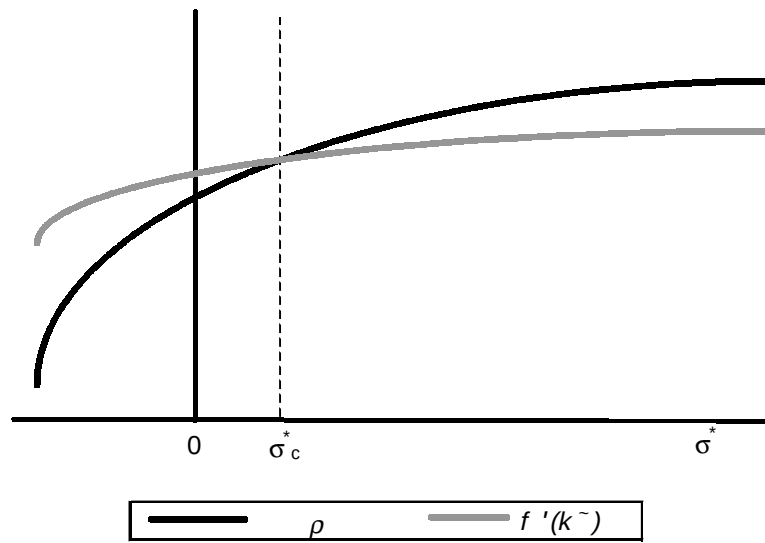
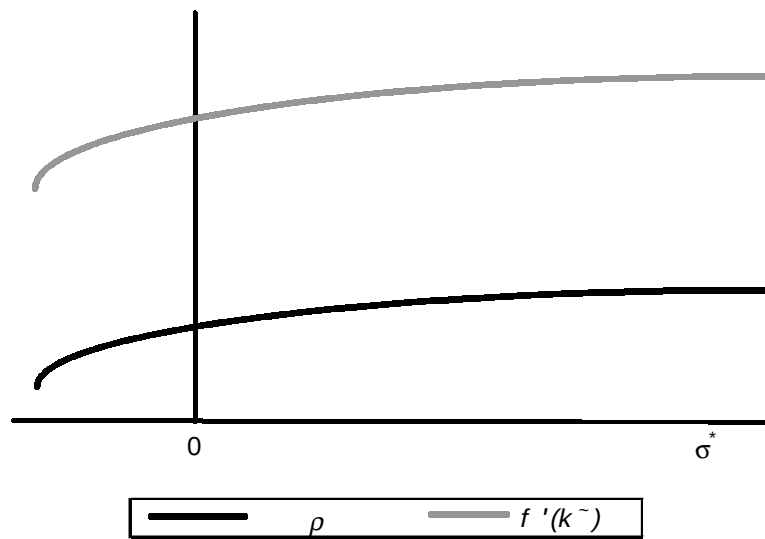
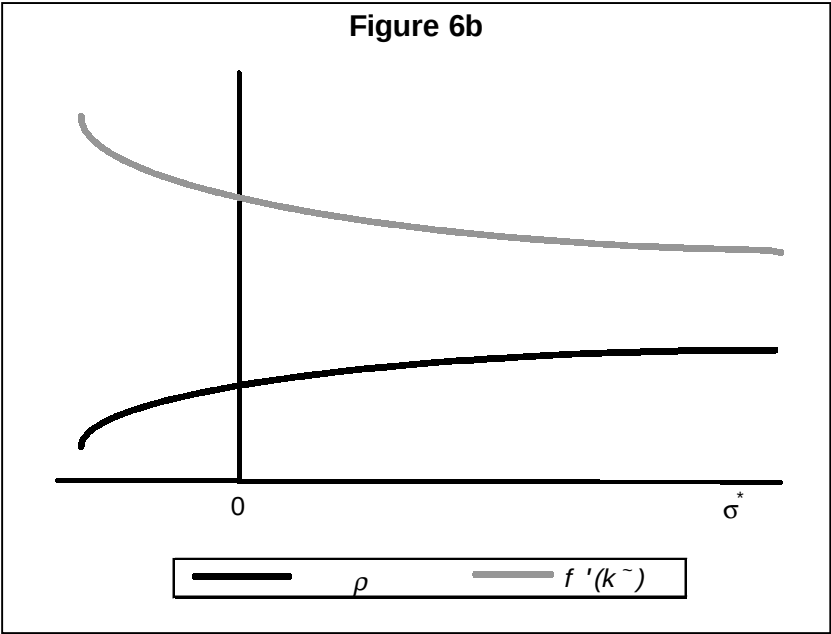
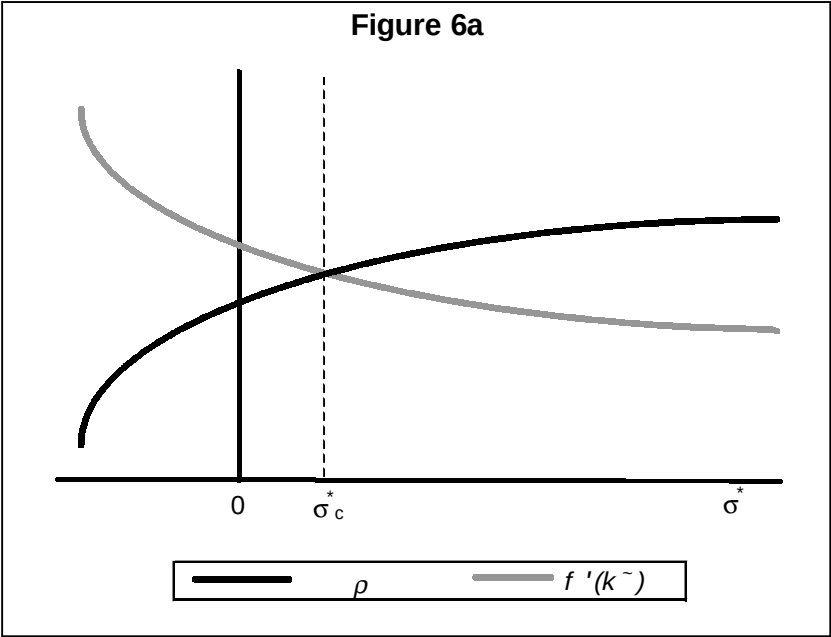
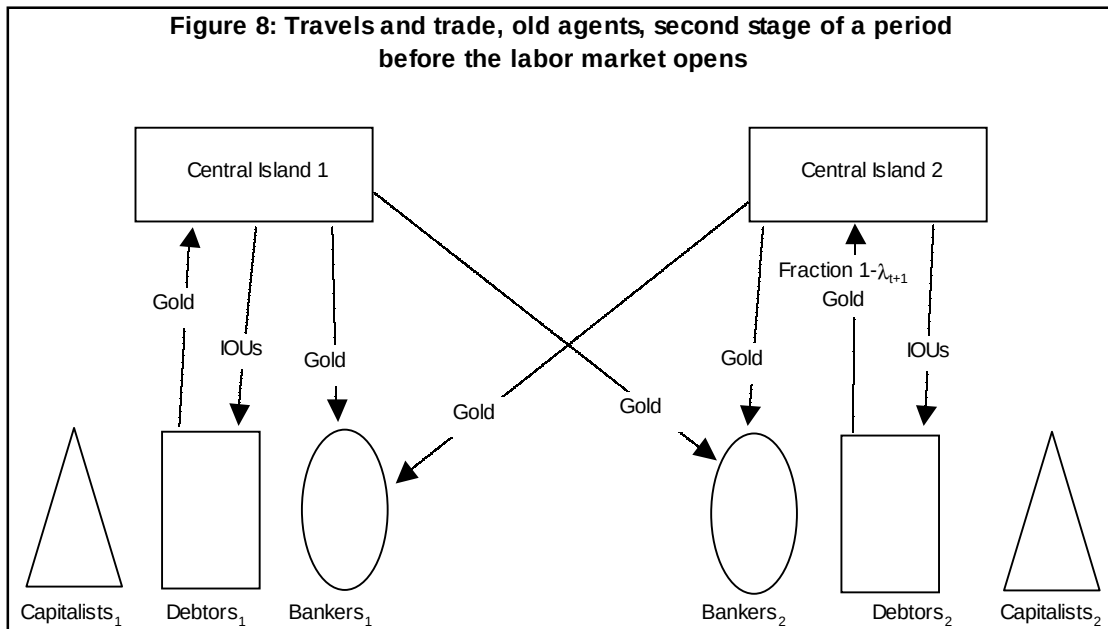
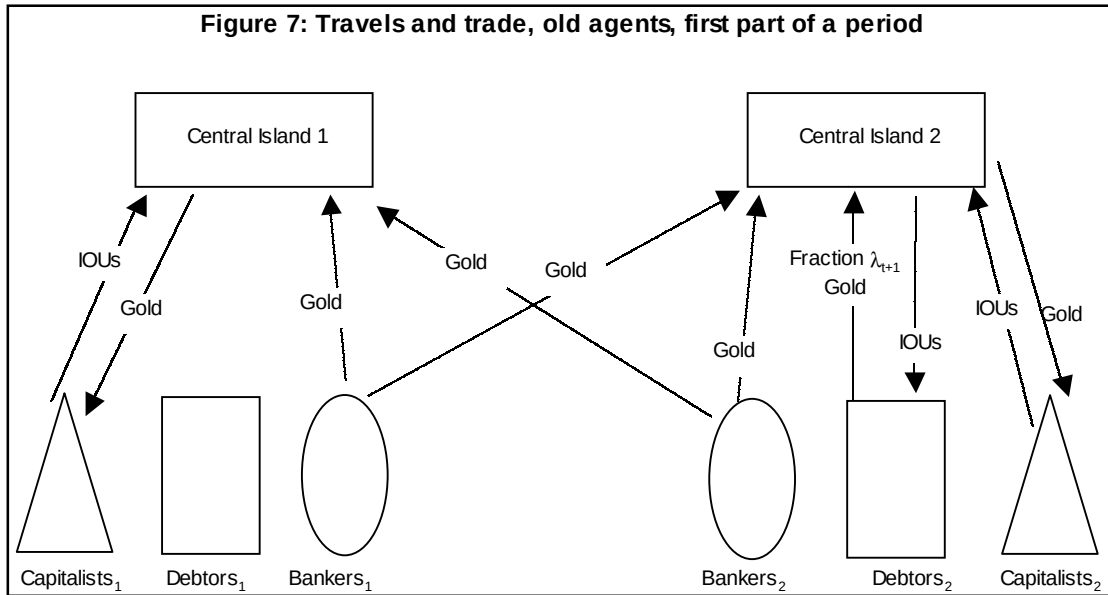


Figure 5b







Tables

Table 1a
Financial Crises during the Antebellum Period (before 1862) Originated by
a Decrease of Specie Reserves in the United Kingdom (Financial Center)
Causes and Policies in the United Kingdom

Crisis	Origin		Bank of England's Policies	
	Country	Reason	Discount rates	Quantitative controls
1836	UK	Drain of specie reserves in the Bank of England in 1836 (cause unknown).	a) From 4% to 4.5%, July. b) From 4.5% to 5%, September.	a) Refused to discount bills of joint-stock banks. b) Refused to handle acceptances of Anglo-American discount houses.
1839	UK	Drain of specie reserves in the Bank of England in 1839 (cause: failure of grain crop in 1838 and subsequent increase in imports of grain).	a) From 4% to 5%, May. b) From 5% to 5.5%, June. c) From 5.5% to 6%, August.	None.
1845	UK	Drain of specie in UK, 1846 (cause: Irish potato famine and trade deficit).	Not initially. From 3% to approximately 5.25% between January and April, 1847.	Suspension of the Act of 1844 in 1847.
1856	UK	Drain of specie in UK, 1856.	Yes, from 5% to 10%, October.	Suspension of the Act of 1844 in November of 1856 (second stage).

Source: Dornbusch and Frenkel (1984), Huffman and Lothian (1984), Temin (1969).

Table 1b
Financial Crises during the Antebellum Period (before 1862) Originated by
a Decrease of Specie Reserves in the United Kingdom (Financial Center)
Effects in the United Kingdom and in the United States

Crisis	Specie Stock in US	Financial Panics		Contraction	
		UK	US	UK	US
1836	Reduction in growth rate in 1836.	No, but some banks suspended payments.	Yes, 1837.	1836-1837 Mild: real GNP fell 1.5%.	1836-1838 Severe: domestic trade index fell 5.5% and foreign trade index fell 16.5% 1/.
1839	Absolute fall between 1839 and 1842, lagged relative to UK.	No.	Suspension of specie payments in the majority of banks (not in New York or New England).	1839-1842, as severe as the Great depression. Total decline in real GNP of 7.2%.	1839-1843, as sharp as in UK.
1845	Sizable reduction after the Bank of England increased discount rate.	Yes, severe and widespread, in 1847.	Yes, but not severe: Treasury purchased government securities to offset declines in money multiplier.	1845-1848: a reduction in real GNP growth rate from 6.4% the first year to below 1% on average. Mild.	1845 and 1848: an absolute fall in real activity 1/. Mild fall in 1845 and substantial fall in 1848. More severe.
1856	Internal drain in East Coast. Then decrease in growth rate.	Yes, as a consequence of the panic in US.	Yes, first. Panic and bank runs.	1857-58: brief business contraction Milder than in US.	1856-58: contraction more protracted More severe.

1/ Smith and Cole's (1935), as reported by Huffman and Lothian (1984).

Source: Dornbusch and Frenkel (1984), Huffman and Lothian (1984), Temin (1969).

Table 2 a
Financial Crises during the Greenback Period (1862-1879) Originated by
a Decrease of Specie Reserves in the United Kingdom (Financial Center)
Causes and Policies in the United Kingdom

Crisis	Origin		Bank of England's Policies	
	Country	Reason	Discount rates	Quantitative controls
1866	UK	Drain of specie reserves in the Bank of England in late 1865.	Yes, sharp. ^{1/}	Suspension of the Act of 1844 in February, 1866.

^{1/} The sources do not provide more specific information.

Source: Dornbusch and Frenkel (1984), Huffman and Lothian (1984), Temin (1969).

Table 2 b
Financial Crises during the Greenback Period (1862-1879) Originated by
a Decrease of Specie Reserves in the United Kingdom (Financial Center)
Effects in the United Kingdom and in the United States

Crisis	Specie Stock in US	Financial Panics		Contraction	
		UK	US	UK	US
1866	No effect.	Yes, with failure of important financial firms.	No.	Yes, but not severe: decline of rate of growth. ^{1/}	No effect at all.

^{1/} Smith and Cole's (1935), as reported by Huffman and Lothian (1984).

Source: Dornbusch and Frenkel (1984), Huffman and Lothian (1984), Temin (1969).

Appendix A

Technical Appendix for Chapter I

1 Proofs of Propositions and Lemmas in Section 2

Proposition 1. *In a Walrasian steady-state equilibrium, an increase in the steady-state rate of domestic inflation (σ) reduces the capital-labor ratio ($\hat{k}$), reversing the Mundell-Tobin effect. In addition, the ratio of investment abroad to total savings in a Walrasian stationary allocation ($\hat{\chi}$) is increasing in the steady-state domestic inflation rate.*

Proof. Using equation (36) in Chapter I, and differentiating both sides with respect to σ , one obtains

$$\frac{\partial \hat{k}}{\partial \sigma} = - \frac{\phi_d \left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]^{\frac{2-\alpha}{\alpha-1}}}{(1-\alpha)(1+\sigma)^2 [\alpha A(1-\phi_d - \phi_f)]^{\frac{1}{\alpha-1}}} < 0. \quad (\text{A.1})$$

Equation (A.1) proves the first part of the proposition. For the second part, differentiate the definition of ε in (28). One can easily determine that

$$\frac{\partial \varepsilon}{\partial \sigma} = - \frac{\phi_d (1-\phi_d - \phi_f)}{[(1-\phi_d - \phi_f) + \sigma(1-\phi_f)]^2} < 0. \quad (\text{A.2})$$

Then, given that $\varepsilon > 0, \forall \sigma > \sigma_\varepsilon$, we can easily determine from equation (38) in Chapter I that

$$\frac{\partial \hat{\chi}}{\partial \sigma} = - \left[\frac{1}{\lambda(1-\alpha)A(1-\phi_d-\phi_f)} \right] \left[\hat{k}^{1-\alpha} \frac{\partial \varepsilon}{\partial \sigma} + \varepsilon(1-\alpha)\hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial \sigma} \right] > 0. \quad (\text{A.3})$$

Equation (A.3) proves the second part of the proposition. Q.E.D.

Proposition 2. *An increase in either the steady-state rate of inflation in the rest of the world (σ^*) or the international interest rate on deposits (r) reduces the capital-labor ratio ($\hat{k}$) and increases the ratio of investment abroad to total savings ($\hat{\chi}$) in a Walrasian steady-state equilibrium.*

Proof. From equation (36) in Chapter I, one obtains the following:

$$\frac{\partial \hat{k}}{\partial \sigma^*} = - \frac{\phi_f \hat{k}}{(1-\alpha)(1+\sigma^*)^2 \left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]} < 0, \text{ and} \quad (\text{A.4})$$

$$\frac{\partial \hat{k}}{\partial r} = - \frac{\hat{k}}{(1-\alpha) \left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]} < 0. \quad (\text{A.5})$$

(A.4) and (A.5) prove the first part of the proposition. In addition, differentiating (38) in Chapter I with respect to σ^* and r , respectively, one obtains

$$\frac{\partial \hat{\chi}}{\partial \sigma^*} = \frac{\alpha \varepsilon \phi_f}{(1-\alpha)\lambda(1+\sigma^*)^2 \left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]^2} > 0, \text{ and} \quad (\text{A.6})$$

$$\frac{\partial \hat{\chi}}{\partial r} = \frac{\alpha \varepsilon}{(1-\alpha)\lambda \left[r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]^2} > 0. \quad (\text{A.7})$$

(A.6) and (A.7) prove the second part of the proposition. Q.E.D.

Proposition 3. *An increase in either the required reserves held in domestic currency (ϕ_d) or the required reserves held in foreign currency (ϕ_f) reduces the capital-labor ratio ($\hat{k}$) in a Walrasian regime.*

Proof. Differentiating equation (36) in Chapter I with respect to ϕ_d we obtain

$$\frac{\partial \hat{k}}{\partial \phi_d} = - \left[\frac{\alpha A}{(1-\alpha)\rho^2} \right] \hat{k}^\alpha \left[\frac{r - \left(\frac{1}{1+\sigma} \right) + \phi_f \left(\frac{1}{1+\sigma} - \frac{1}{1+\sigma^*} \right)}{(1-\phi_d - \phi_f)^2} \right], \quad (\text{A.8})$$

which implies that

$$\frac{\partial \hat{k}}{\partial \phi_d} < (>) \text{ if } \sigma > (<) \sigma_1 \equiv \frac{(1-r) + \phi_f \left(\frac{1}{1+\sigma^*} - 1 \right)}{\left(r - \frac{\phi_f}{1+\sigma^*} \right)}. \quad (\text{A.9})$$

However, it can be easily shown that $r > \left(\frac{1}{1+\sigma^*} \right)$ implies

$$\sigma_1 < \left(\frac{1}{r} - 1 \right) \quad (\text{A.10})$$

Therefore, since the reserve requirements bind, $\sigma > \sigma_1$ holds and, thus $\frac{\partial \hat{k}}{\partial \phi_d} < 0$,

$\forall \sigma > \text{Max}\left\{\sigma_\varepsilon, \left(\frac{1}{r} - 1\right)\right\}$. This proves the first part of this proposition. To prove the

second part of this proposition, differentiate (36) in Chapter I with respect to ϕ_f to obtain

$$\frac{\partial \hat{k}}{\partial \phi_f} = - \left[\frac{\alpha A}{(1-\alpha)\rho^2} \right] \hat{k}^\alpha \left[\frac{r - \left(\frac{\phi_d}{1+\sigma} \right) - \left(\frac{1-\phi_d}{1+\sigma^*} \right)}{(1-\phi_d - \phi_f)^2} \right], \quad (\text{A.11})$$

which in turn implies that

$$\frac{\partial \hat{k}}{\partial \phi_f} < (>) 0 \text{ if } \sigma > (<) \sigma_2 \equiv \frac{\phi_d + \left(\frac{1-\phi_d}{1+\sigma^*} \right) - r}{\left[r - \left(\frac{1-\phi_d}{1+\sigma^*} \right) \right]}. \quad (\text{A.12})$$

However, it can be easily shown that $r > \left(\frac{1}{1+\sigma^*} \right)$ implies

$$\sigma_2 < \left(\frac{1}{r} - 1 \right) \quad (\text{A.13})$$

Then, again $\sigma > \sigma_2$ holds and, thus $\frac{\partial \hat{k}}{\partial \phi_f} < 0$, $\forall \sigma > \text{Max}\left\{\sigma_\varepsilon, \left(\frac{1}{r} - 1\right)\right\}$, proving the

second part of this proposition. Q.E.D.

Proposition 4. Suppose that

$$r(1-\lambda)(1-\alpha) < (>) \alpha\pi \quad (41)$$

holds¹. Then an increase in the domestic rate of inflation increases (reduces) the steady-state capital-labor ratio $\tilde{k}$. If an increase in the domestic inflation rate reduces $\tilde{k}$, then the same increase necessarily increases the fraction of savings invested abroad ($\tilde{\chi}$).

Proof. Differentiating equation (39) in Chapter I with respect to σ , one obtains

$$\frac{\partial \tilde{k}}{\partial \sigma} = \left\{ \frac{\pi}{(1-\alpha)A[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \tilde{k}^{2-\alpha} \left\{ \varepsilon \frac{\partial \rho}{\partial \sigma} + \rho \frac{\partial \varepsilon}{\partial \sigma} \right\}, \quad (\text{A.14})$$

where

$$\varepsilon \frac{\partial \rho}{\partial \sigma} + \rho \frac{\partial \varepsilon}{\partial \sigma} = \frac{\phi_d \left[(1-r) + \phi_f \left(\frac{1}{1+\sigma^*} - 1 \right) \right]}{\left[(1-\phi_d - \phi_f) + \sigma(1-\phi_f) \right]^2} < 0, \text{ given } r > 1 \text{ and } r > \left(\frac{1}{1+\sigma^*} \right) \quad (\text{A.15})$$

Thus, $\frac{\partial \tilde{k}}{\partial \sigma} > (<) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$, which proves the first part of the

proposition. Differentiating equation (40) in Chapter I with respect to σ , yields

$$\frac{\partial \tilde{\chi}}{\partial \sigma} = - \left[\frac{\tilde{k}^{-\alpha}}{\lambda(1-\alpha)A(1-\phi_d - \phi_f)} \right] \left\{ \tilde{k} \frac{\partial \varepsilon}{\partial \sigma} + \varepsilon(1-\alpha) \frac{\partial \tilde{k}}{\partial \sigma} \right\}. \quad (\text{A.16})$$

Using (A.2), and the fact that $\varepsilon > 0, \forall \sigma > \sigma_\varepsilon$, it is clear that if $\frac{\partial \tilde{k}}{\partial \sigma} < 0$, then it must be

the case that $\frac{\partial \tilde{\chi}}{\partial \sigma} > 0$. Q.E.D.

¹ Of course if $r(1-\lambda)(1-\alpha) > (<) \alpha\pi$, $(1-\pi)x > (<) \varepsilon\rho$ must hold in order for $f'(\tilde{k})$ to be well-defined.

Proposition 5. Suppose that (41) holds. Then an increase in the foreign inflation rate (σ^*) or the world real (r) reduces (increases) the domestic capital-labor ratio $\tilde{k}$. These same changes increase (reduce) the ratio of savings done abroad ($\tilde{\chi}$).

Proof. Differentiating equation (39) in Chapter I with respect to σ^* , yields

$$\frac{\partial \tilde{k}}{\partial \sigma^*} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{(1-\alpha)A[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left[\frac{\varepsilon \phi_d}{(1-\phi_d - \phi_f)(1+\sigma^*)^2} \right], \quad (\text{A.17})$$

and, thus $\frac{\partial \tilde{k}}{\partial \sigma^*} < (>) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. Differentiating equation (39) in Chapter

I with respect to r , yields

$$\frac{\partial \tilde{k}}{\partial r} = \tilde{k} \left\{ \frac{(1-\lambda)}{[r(1-\lambda)(1-\alpha) - \alpha\pi]} + \frac{\pi \varepsilon [(1-\pi)x - \pi \varepsilon \rho]^{-1}}{(1-\alpha)(1-\phi_d - \phi_f)} \right\}, \quad (\text{A.18})$$

and thus, $\frac{\partial \tilde{k}}{\partial r} < (>) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. Notice that (A.17) and (A.18) prove the

first part of the proposition. Differentiating (40) in Chapter I with respect to σ^* , gives the following:

$$\frac{\partial \tilde{\chi}}{\partial \sigma^*} = - \left[\frac{\varepsilon(1-\alpha)\tilde{k}^{-\alpha}}{\lambda(1-\alpha)A(1-\phi_d - \phi_f)} \right] \frac{\partial \tilde{k}}{\partial \sigma^*}, \quad (\text{A.19})$$

and thus, $\frac{\partial \tilde{\chi}}{\partial \sigma^*} > (<) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. Differentiating (40) with respect to r

one gets

$$\frac{\partial \tilde{\chi}}{\partial r} = - \left[\frac{\varepsilon(1-\alpha)\tilde{k}^{-\alpha}}{\lambda(1-\alpha)A(1-\phi_d-\phi_f)} \right] \frac{\partial \tilde{k}}{\partial r}, \quad (\text{A.20})$$

and thus, $\frac{\partial \tilde{\chi}}{\partial r} > (<) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. Notice that (A.19) and (A.20) prove the second part of the proposition. Q.E.D.

Proposition 6. *Suppose that (41) in Chapter I holds. Then an increase in the required reserves held in domestic currency (ϕ_d) reduces (increases) the capital-labor ratio ($\tilde{k}$). On the other hand, an increase in the required reserves held in foreign currency (ϕ_f) reduces (increases) the capital-labor ratio ($\tilde{k}$) if $\sigma > \left\{ \frac{\sigma^* \phi_d}{[r(1+\sigma^*)-1]} - 1 \right\}$ but increases*

(reduces) $\tilde{k}$ if $\sigma < \left\{ \frac{\sigma^* \phi_d}{[r(1+\sigma^*)-1]} - 1 \right\}$.

Proof. Differentiating equation (39) in Chapter I with respect to ϕ_d allows one to show that

$$\frac{\partial \tilde{k}}{\partial \phi_d} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left\{ \varepsilon \frac{\partial \rho}{\partial \phi_d} + \rho \frac{\partial \varepsilon}{\partial \phi_d} \right\} \quad (\text{A.21})$$

where

$$\left\{ \varepsilon \frac{\partial \rho}{\partial \phi_d} + \rho \frac{\partial \varepsilon}{\partial \phi_d} \right\} = \frac{(1+\sigma) \left[(r-1) + \phi_f \left(1 - \frac{1}{1+\sigma^*} \right) \right]}{[(1-\phi_d-\phi_f) + \sigma(1-\phi_f)]^2} > 0 \quad (\text{A.22})$$

given $r > 1$ and $r > \frac{1}{1+\sigma^*}$.

Thus, from (A.21) and (A.22), $\frac{\partial \tilde{k}}{\partial \phi_d} < (>) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. This proves the first part of the proposition.

Similarly, differentiating (39) in Chapter I with respect to ϕ_f , one gets

$$\frac{\partial \tilde{k}}{\partial \phi_f} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left\{ \varepsilon \frac{\partial \rho}{\partial \phi_f} + \rho \frac{\partial \varepsilon}{\partial \phi_f} \right\} \quad (\text{A.23})$$

where

$$\left\{ \varepsilon \frac{\partial \rho}{\partial \phi_f} + \rho \frac{\partial \varepsilon}{\partial \phi_f} \right\} = \frac{(1+\sigma) \left\{ (1+\sigma) \left[r - \left(\frac{1}{1+\sigma^*} \right) \right] - \phi_d \left(\frac{\sigma^*}{1+\sigma^*} \right) \right\}}{[(1-\phi_d - \phi_f) + \sigma(1-\phi_f)]^2} \quad (\text{A.24})$$

Then, it is possible to show that

$$\left\{ \varepsilon \frac{\partial \rho}{\partial \phi_f} + \rho \frac{\partial \varepsilon}{\partial \phi_f} \right\} > (<) 0 \text{ if } \sigma > (<) \left\{ \frac{\sigma^* \phi_d}{[r(1+\sigma^*) - 1]} - 1 \right\}. \quad (\text{A.25})$$

Therefore, $\frac{\partial \tilde{k}}{\partial \phi_f} < (>) 0$ when $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ and

$\sigma > \left\{ \frac{\sigma^* \phi_d}{[r(1+\sigma^*) - 1]} - 1 \right\}$, but $\frac{\partial \tilde{k}}{\partial \phi_f} > (<) 0$ when $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$ and

$\sigma < \left\{ \frac{\sigma^* \phi_d}{[r(1+\sigma^*) - 1]} - 1 \right\}$. The latter proves the second part of the proposition. Q.E.D.

Lemma 7. *The steady-state interest rate on loans is a monotonically increasing and concave function of the steady-state domestic inflation rate, for any $\sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right), \sigma_\varepsilon\right\}$, and it is bounded above.*

Proof. Using equation (35) in Chapter I, it is easy to show that

$$\frac{\partial \rho}{\partial \sigma} = \frac{\phi_d}{(1-\phi_d-\phi_f)(1+\sigma)^2} > 0, \quad \forall \sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right), \sigma_\varepsilon\right\} \quad (\text{A.26})$$

and that

$$\frac{\partial^2 \rho}{\partial \sigma^2} = -\frac{2\phi_d}{(1-\phi_d-\phi_f)(1+\sigma)^3} < 0, \quad \forall \sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right), \sigma_\varepsilon\right\} \quad (\text{A.27})$$

Therefore, ρ is monotonically increasing and strictly concave in σ , for any

$\sigma > \text{Max}\left\{\left(\frac{1}{r}-1\right), \sigma_\varepsilon\right\}$. Moreover,

$$\lim_{\sigma \rightarrow \infty} \rho = \frac{\left[r - \left(\frac{\phi_f}{1+\sigma^*}\right)\right]}{(1-\phi_d-\phi_f)} > 0 \quad (\text{A.28})$$

proving that ρ is bounded above. Q.E.D.

2 Technical Notes on Local Stability Analysis in Section 2

Equation (46) in Chapter I can be arranged to obtain the following expression:

$$\left(\frac{1+\sigma}{\phi_d} \right) \left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right] - E \left(\frac{1-\pi}{\pi} \right) x = 1 + Ef'(\tilde{k}) - Ef'(\tilde{k}) \left[\frac{r(1-\lambda)(1-\alpha)}{\alpha\pi} \right]. \quad (\text{A.29})$$

Using (A.29), it is possible to obtain the following expression for the trace of the Jacobian:

$$T = J_{11} = 1 + (1-\alpha)Ef'(\tilde{k}) - Ef'(\tilde{k}) \left[\frac{r(1-\lambda)(1-\alpha)}{\alpha\pi} \right]. \quad (\text{A.30})$$

Then, using (A.30), equations (51) and (52) in Chapter I are easily obtained.

In addition, recall from equation (32) in Chapter I that it is necessary to impose $\sigma > \sigma_\epsilon$ for lending to be positive. Then, $E > 0$ follows directly from this condition.

Finally, in the remainder of this section, I show that $Ef'(\tilde{k})$ is always increasing in σ . Using equations (39) and (50) in Chapter I, yields

$$Ef'(\tilde{k}) = \Gamma(1-\pi)x \left[(1-\phi_d - \phi_f) + \sigma(1-\phi_f) \right] - \Gamma\pi \left[r(1+\sigma) - \phi_d - (1+\sigma) \left(\frac{\phi_f}{1+\sigma^*} \right) \right] \quad (\text{A.31})$$

where

$$\Gamma \equiv \left\{ \frac{\alpha}{\phi_d [r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \quad (\text{A.32})$$

Notice that $\Gamma < (>) 0$ if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$. Differentiating (A.31) with respect to σ , we obtain

$$\frac{\partial [Ef'(\tilde{k})]}{\partial \sigma} = \Gamma \left\{ (1-\pi)x(1-\phi_f) - \pi \left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right] \right\}. \quad (\text{A.33})$$

It is also useful to notice that

$$\lim_{\sigma \rightarrow \infty} \varepsilon \rho = \frac{\left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]}{(1-\phi_f)}. \quad (\text{A.34})$$

Thus, the following must be true:

a) If $r(1-\lambda)(1-\alpha) < \alpha\pi$, then $(1-\pi)x < \pi \frac{\left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]}{(1-\phi_f)}$ for $\tilde{k}$ to be

well defined. In addition, as I mentioned before, $\Gamma < 0$.

b) If $r(1-\lambda)(1-\alpha) > \alpha\pi$, then $(1-\pi)x > \pi \frac{\left[r - \left(\frac{\phi_f}{1+\sigma^*} \right) \right]}{(1-\phi_f)}$ for $\tilde{k}$ to be

well defined. Also, notice that, as I mentioned before, $\Gamma > 0$.

Thus, from (A.33), it follows that $\frac{\partial [Ef'(\tilde{k})]}{\partial \sigma} > 0$ always holds.

3 Technical Notes on (Steady-State) Comparative Statics in Section 3

3.1 Steady-State Equilibria in a Walrasian Regime

3.1.1 Comparative Statics with respect to the Policy Parameters θ and ξ

Differentiating equation (65) in Chapter I with respect to θ and ξ , respectively, I obtain

$$\frac{\partial \delta}{\partial \theta} = \frac{\phi_d (1 + \sigma^*)^2 (r - 1)(1 - \phi_d - \phi_f)}{\left[(1 + \sigma^*)(r - 1)(\theta \phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f) \right]^2} > 0, \text{ given } r > 1, \quad (\text{A.35})$$

and

$$\frac{\partial \delta}{\partial \xi} = \frac{(1 + \sigma^*)^2 (r - 1)(1 - \phi_d - \phi_f)}{\left[(1 + \sigma^*)(r - 1)(\theta \phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f) \right]^2} \text{ given } r > 1. \quad (\text{A.36})$$

Thus, δ is increasing in both θ and ξ .

In addition, differentiating equation (63) in Chapter I also with respect to θ and ξ , respectively, one gets

$$\frac{\partial \hat{\tau}}{\partial \theta} = \left(\frac{\hat{k}}{1 - \lambda} \right) \frac{\partial \delta}{\partial \theta} > 0, \text{ given } \frac{\partial \hat{k}}{\partial \theta} = 0, \quad (\text{A.37})$$

and

$$\frac{\partial \hat{\tau}}{\partial \xi} = \left(\frac{\hat{k}}{1 - \lambda} \right) \frac{\partial \delta}{\partial \xi} > 0, \text{ given } \frac{\partial \hat{k}}{\partial \xi} = 0. \quad (\text{A.38})$$

Finally, differentiating equation (64) in Chapter I with respect to θ and ξ , respectively, yields

$$\frac{\partial \hat{\chi}}{\partial \theta} = \left[\frac{\hat{k}^{1-\alpha}}{\lambda A(1-\alpha)(1-\phi_d - \phi_f)} \right] \frac{\partial \delta}{\partial \theta} > 0, \text{ given } \frac{\partial \hat{k}}{\partial \theta} = 0, \quad (\text{A.39})$$

and

$$\frac{\partial \hat{\chi}}{\partial \xi} = \left[\frac{\hat{k}^{1-\alpha}}{\lambda A(1-\alpha)(1-\phi_d - \phi_f)} \right] \frac{\partial \delta}{\partial \xi} > 0, \text{ given } \frac{\partial \hat{k}}{\partial \xi} = 0. \quad (\text{A.40})$$

3.1.2 Effects of Increases in σ^* , r , ϕ_d or ϕ_f on the capital-labor ratio ($\hat{k}$)

Given equation (62) in Chapter I, it is obvious that there is a negative relationship between $\hat{k}$ and ρ . Then, it will be sufficient to show the effects of σ^* , r , ϕ_d and ϕ_f on ρ .

Differentiating (56) in Chapter I with respect to σ^* , r , ϕ_d and ϕ_f respectively, gives

$$\frac{\partial \rho}{\partial \sigma^*} = \frac{(\phi_d + \phi_f)}{(1-\phi_d - \phi_f)(1+\sigma^*)} > 0, \quad (\text{A.41})$$

$$\frac{\partial \rho}{\partial r} = \frac{1}{(1-\phi_d - \phi_f)} > 0, \quad (\text{A.42})$$

$$\frac{\partial \rho}{\partial \phi_d} = \frac{\partial \rho}{\partial \phi_f} = \frac{\left[r - \left(\frac{1}{1+\sigma^*} \right) \right]}{(1-\phi_d - \phi_f)^2} > 0. \quad (\text{A.43})$$

Thus, it follows from (A.41), (A.42) and (A.43) that increases in σ^* , r , ϕ_d and ϕ_f reduce $\hat{k}$.

3.1.3 Effects of Increases in σ^* on both δ and $\hat{\chi}$

Differentiating equation (65) in Chapter I with respect to σ^* yields

$$\frac{\partial \delta}{\partial \sigma^*} = \frac{\phi_d (1 - \phi_d - \phi_f)}{\left[(1 + \sigma^*)(r - 1)(\theta \phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^* (1 - \phi_f) \right]^2} > 0. \quad (\text{A.44})$$

Thus, δ is always increasing in σ^* .

Differentiating equation (64) in Chapter I with respect to σ^* we obtain the following expression

$$\frac{\partial \hat{\chi}}{\partial \sigma^*} = \left[\frac{1}{\lambda A (1 - \alpha) (1 - \phi_d - \phi_f)} \right] \left\{ (\delta - 1)(1 - \alpha) \hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial \sigma^*} + \hat{k}^{1-\alpha} \frac{\partial \delta}{\partial \sigma^*} \right\} > 0. \quad (\text{A.45})$$

Notice that $(\delta - 1) < 0$ for lending to be positive.

3.1.4 Comparative Statics under a Currency Board

In a currency board, the subsidy rate on capital can be written as

$$\delta = \frac{(1 + \sigma^*)(r - 1)(\phi_d + \xi) + \sigma^* \phi_d}{\left[(1 + \sigma^*)(r - 1)(\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^* (1 - \phi_f) \right]}. \quad (\text{A.46})$$

Differentiating (A.46) with respect to r , one obtains

$$\frac{\partial \delta}{\partial r} = \frac{(1 + \sigma^*)^2 (\phi_d + \xi)(1 - \phi_d - \phi_f)}{\left[(1 + \sigma^*)(r - 1)(\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f) \right]^2}. \quad (\text{A.47})$$

Thus, the subsidy rate on capital δ is increasing in r .

On the other hand, differentiating equation (64) in Chapter I with respect to r , we obtain the following expression

$$\frac{\partial \hat{\chi}}{\partial r} = \left[\frac{1}{\lambda A(1 - \alpha)(1 - \phi_d - \phi_f)} \right] \left\{ (\delta - 1)(1 - \alpha) \hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial r} + \hat{k}^{1-\alpha} \frac{\partial \delta}{\partial r} \right\} > 0. \quad (\text{A.48})$$

Then, the share of net investment abroad in total savings is increasing in the world interest rate r .

Regarding the effects of changes in domestic reserve requirements, I start with the analysis of increases in ϕ_d . Differentiating (A.46) with respect to ϕ_d , one gets

$$\frac{\partial \delta}{\partial \phi_d} = \frac{(1 + \sigma^*) \left\{ (1 + \sigma^*)(r - 1)(1 - \phi_f + \xi) + \sigma^*(1 - \phi_f) \right\}}{\left[(1 + \sigma^*)(r - 1)(\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f) \right]^2}. \quad (\text{A.49})$$

Notice that the expression $\left\{ (1 + \sigma^*)(r - 1)(1 - \phi_f + \xi) + (1 - \phi_f) \right\}$ in the numerator of (A.49) is increasing in σ^* . Thus, it follows that

$$\frac{\partial \delta}{\partial \phi_d} > 0 \Leftrightarrow \sigma^* > - \left[\frac{(r - 1)(1 - \phi_f + \xi)}{(r - 1)(1 - \phi_f + \xi) + (1 - \phi_f)} \right] > -1. \quad (\text{A.50})$$

This condition always holds if

$$\left(\frac{1}{r} - 1 \right) \geq - \left[\frac{(r - 1)(1 - \phi_f + \xi)}{(r - 1)(1 - \phi_d + \xi) + (1 - \phi_f)} \right] \Leftrightarrow \xi \geq 0. \quad (\text{A.51})$$

Obviously, (A.51) always holds under a currency board and, therefore, $\frac{\partial \delta}{\partial \phi_d} > 0$.

Using this result, as well as the fact that $\hat{k}$ is decreasing in ϕ_d , it is straightforward to show that $\hat{\chi}$ is increasing in ϕ_d : differentiating (64) in Chapter I gives

$$\frac{\partial \hat{\chi}}{\partial \phi_d} = \left[\frac{1}{\lambda A(1-\alpha)(1-\phi_d-\phi_f)} \right] \left\{ (\delta-1)(1-\alpha)\hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial \phi_d} + \hat{k}^{1-\alpha} \frac{\partial \delta}{\partial \phi_d} \right\} > 0 \quad (\text{A.52})$$

Similarly, differentiating (46) with respect to ϕ_f yields

$$\frac{\partial \delta}{\partial \phi_f} = \frac{(1+\sigma^*)\{(1+\sigma^*)(r-1)(\phi_d+\xi) + \sigma^*\phi_d\}}{[(1+\sigma^*)(r-1)(\phi_d+\xi) + (1-\phi_d-\phi_f) + \sigma^*(1-\phi_f)]^2}. \quad (\text{A.53})$$

Notice that the expression $\{(1+\sigma^*)(r-1)(\phi_d+\xi) + \sigma^*\phi_d\}$ in the numerator of (A.53) is increasing in σ^* . It follows, then, that

$$\frac{\partial \delta}{\partial \phi_f} > 0 \Leftrightarrow \sigma^* > -\left[\frac{(r-1)(\phi_d+\xi)}{(r-1)(\phi_d+\xi) + \phi_d} \right] > -1. \quad (\text{A.54})$$

This condition always holds if

$$\left(\frac{1}{r} - 1 \right) \geq -\left[\frac{(r-1)(\phi_d+\xi)}{(r-1)(\phi_d+\xi) + \phi_d} \right] \Leftrightarrow \xi \geq 0. \quad (\text{A.55})$$

Again, it is obvious that (A.55) always holds under a currency board and therefore,

$\frac{\partial \delta}{\partial \phi_f} > 0$. Using this result, as well as the fact that $\hat{k}$ is decreasing in ϕ_f , it is

straightforward to show that $\hat{\chi}$ is increasing in ϕ_f . Thus, differentiating (64) in Chapter I, one obtains

$$\frac{\partial \hat{\chi}}{\partial \phi_f} = \left[\frac{1}{\lambda A(1-\alpha)(1-\phi_d - \phi_f)} \right] \left\{ (\delta - 1)(1-\alpha) \hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial \phi_f} + \hat{k}^{1-\alpha} \frac{\partial \delta}{\partial \phi_f} \right\} > 0 \quad (\text{A.56})$$

3.1.5 Comparative Statics under a Pure Fixed Exchange Rate

In a pure fixed exchange rate regime, the subsidy rate on capital can be written as

$$\delta = \frac{\sigma^* \phi_d}{[(1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]}. \quad (\text{A.57})$$

By inspection of (A.57), it is obvious that $\frac{\partial \delta}{\partial r} = 0$. It follows that

$$\frac{\partial \hat{\chi}}{\partial r} = \left[\frac{1}{\lambda A(1-\alpha)(1-\phi_d - \phi_f)} \right] \left\{ (\delta - 1)(1-\alpha) \hat{k}^{-\alpha} \frac{\partial \hat{k}}{\partial r} \right\} > 0. \quad (\text{A.58})$$

Thus, the share of net investment abroad in total savings is always increasing in r .

Next, differentiate (A.57) with respect to ϕ_d to obtain

$$\frac{\partial \delta}{\partial \phi_d} = \frac{\sigma^*(1+\sigma^*)(1-\phi_f)}{[(1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2}. \quad (\text{A.59})$$

In addition, differentiating equation (64) in Chapter I with respect to ϕ_d , yields

$$\frac{\partial \hat{\chi}}{\partial \phi_d} = \left[\frac{\alpha}{\lambda(1-\alpha)(1-\phi_d - \phi_f)} \right] \left[\frac{\rho \frac{\partial \delta}{\partial \phi_d} + (1-\delta) \frac{\partial \rho}{\partial \phi_d}}{\rho^2} \right]. \quad (\text{A.60})$$

Using (A.43), (A.59), and (A.60) I am able to determine that the share of net investment abroad is increasing in ϕ_d for all but very small values of σ^* .

In a similar way, differentiating (A.57) with respect to ϕ_f I obtain

$$\frac{\partial \delta}{\partial \phi_f} = \frac{\sigma^* (1 + \sigma^*) \phi_d}{[(1 - \phi_d - \phi_f) + \sigma^* (1 - \phi_f)]^2} \quad (\text{A.61})$$

Differentiating equation (64) in the paper with respect to ϕ_f , I obtain

$$\frac{\partial \hat{\chi}}{\partial \phi_f} = \left[\frac{\alpha}{\lambda(1 - \alpha)(1 - \phi_d - \phi_f)} \right] \left[\frac{\rho \frac{\partial \delta}{\partial \phi_f} + (1 - \delta) \frac{\partial \rho}{\partial \phi_f}}{\rho^2} \right]. \quad (\text{A.62})$$

Using (A.43), (A.61) and (A.62) I am able to determine that the share of net investment abroad is increasing in ϕ_f for all but very small values of σ^* .

3.2 Steady-State Equilibria in a Credit Rationing Regime

3.2.1 Comparative Statics with respect to the Policy Parameters θ and ξ

Differentiating equation (68) in Chapter I with respect to θ and with respect to ξ , and using (A.35) as well as (A.36) I am able to determine, respectively, that

$$\begin{aligned}\frac{\partial \tilde{k}}{\partial \theta} &= - \left\{ \frac{\pi \rho \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \frac{\partial \delta}{\partial \theta} \\ &= \begin{cases} > 0, \text{ if Case 1 obtains,} \\ < 0, \text{ if Case 2 obtains} \end{cases}\end{aligned}\quad (\text{A.63})$$

and

$$\begin{aligned}\frac{\partial \tilde{k}}{\partial \xi} &= - \left\{ \frac{\pi \rho \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \frac{\partial \delta}{\partial \xi} \\ &= \begin{cases} > 0, \text{ if Case 1 obtains,} \\ < 0, \text{ if Case 2 obtains.} \end{cases}\end{aligned}\quad (\text{A.64})$$

Then, differentiating equation (67) in Chapter I also with respect to θ and with respect to ξ , and using (A.35), (A.36), (A.63), and (A.64), I am able to determine that

$$\frac{\partial \tilde{\tau}}{\partial \theta} = \frac{\left[\tilde{k} \frac{\partial \delta}{\partial \theta} + \delta \frac{\partial \tilde{k}}{\partial \theta} \right]}{(1-\lambda)} > 0 \text{ if Case 1 obtains,} \quad (\text{A.65})$$

and

$$\frac{\partial \tilde{\tau}}{\partial \xi} = \frac{\left[\tilde{k} \frac{\partial \delta}{\partial \xi} + \delta \frac{\partial \tilde{k}}{\partial \xi} \right]}{(1-\lambda)} > 0 \text{ if Case 1 obtains.} \quad (\text{A.66})$$

Finally, differentiating equation (69) in Chapter I with respect to θ and with respect to ξ , and using (A.35), (A.36), (A.63) and (A.64), I am able to determine, respectively, that

$$\begin{aligned} \frac{\partial \tilde{\chi}}{\partial \theta} &= \left[\frac{r(1-\lambda)(1-\alpha) - \alpha\pi}{\lambda(1-\alpha)(1-\phi_d - \phi_f)} \right] \left\{ \frac{(1-\pi)x \frac{\partial \delta}{\partial \theta}}{[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \\ &= \begin{cases} < 0, \text{ if Case 1 obtains} \\ > 0, \text{ if Case 2 obtains} \end{cases} \end{aligned} \quad (\text{A.67})$$

and

$$\begin{aligned} \frac{\partial \tilde{\chi}}{\partial \xi} &= \left[\frac{r(1-\lambda)(1-\alpha) - \alpha\pi}{\lambda(1-\alpha)(1-\phi_d - \phi_f)} \right] \left\{ \frac{(1-\pi)x \frac{\partial \delta}{\partial \xi}}{[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \\ &= \begin{cases} < 0, \text{ if Case 1 obtains} \\ > 0, \text{ if Case 2 obtains} \end{cases}. \end{aligned} \quad (\text{A.68})$$

3.2.2 Comparative Statics under a Currency Board

Proofs of Propositions 8 and 9. In this section I proceed to prove Propositions 8 and 9 together for the case when a currency board is in place.

Proposition 8. Let $\xi_c \equiv \left(\frac{\phi_d}{\phi_d + \phi_f} \right) (1 - \phi_d - \phi_f)$, and let Case 1 obtain.

a) When $\xi \in [0, \xi_c)$, an increase in σ^* causes $\tilde{k}$ to fall and $\tilde{\chi}$ to increase if

$$r < r_c \equiv \frac{(\phi_d + \phi_f)(1 - \theta\phi_d - \xi)}{[\phi_d - (\phi_d + \phi_f)(\theta\phi_d + \xi)]} \quad (\text{A.69})$$

holds².

b) When $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$ then an increase in σ^* causes $\tilde{k}$ to fall, whether $r < r_c$ holds or not. On the other hand, when $r < r_c$, $\tilde{\chi}$ will be increasing

(decreasing) in σ^* if $x < (>)\left(\frac{\pi}{1-\pi}\right)\left(\frac{\phi_d + \phi_f}{\phi_d}\right)$ holds³.

Proposition 9. When Case 2 obtains and $\xi \in [0, \xi_c)$, the share of net investment abroad

in total savings ($\tilde{\chi}$) is decreasing (increasing) in σ^* when $x < (>)\left(\frac{\pi}{1-\pi}\right)\left(\frac{\phi_d + \phi_f}{\phi_d}\right)$. On

the other hand, if $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$, $\tilde{\chi}$ is always increasing in σ^* .

Proof. I start with the analysis of the effects of increases in σ^* on the capital-labor ratio $\tilde{k}$. Differentiating equation (68) in Chapter I with respect to σ^* one obtains

$$\frac{\partial \tilde{k}}{\partial \sigma^*} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left\{ \frac{\partial[(1-\delta)\rho]}{\partial \sigma^*} \right\}. \quad (\text{A.70})$$

In addition, using equations (A.58) and (A.65), gives

$$\frac{\partial[(1-\delta)\rho]}{\partial \sigma^*} = \frac{\{r[(\phi_d + \phi_f)(\theta\phi_d + \xi) - \phi_d] + (\phi_d + \phi_f)(1 - \theta\phi_d - \phi_f - \xi)\}}{\{(1 + \sigma^*)(r-1)(\theta\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f)\}^2}. \quad (\text{A.71})$$

² Note that $r_c > (\phi_d + \phi_f)\left(\frac{1 - \phi_f}{\phi_d}\right)$ holds. As a result, for parameter values that seem to obtain in a Latin American context, r_c is fairly large. Thus, this condition is likely to be satisfied in practice.

³ Note that when $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$ holds, $r_c \geq \left(\frac{\phi_d + \phi_f}{\phi_d}\right)$ holds.

Obviously, under a currency board $\theta=1$ and $\xi \in [0, (1-\phi_d-\phi_f))$, and therefore (A.71)

becomes

$$\frac{\partial[(1-\delta)\rho]}{\partial\sigma^*} = \frac{\{r[(\phi_d + \phi_f)(\phi_d + \xi) - \phi_d] + (\phi_d + \phi_f)(1 - \phi_d - \phi_f - \xi)\}}{\{(1 + \sigma^*)(r-1)(\phi_d + \xi) + (1 - \phi_d - \phi_f) + \sigma^*(1 - \phi_f)\}^2}. \quad (\text{A.72})$$

Notice that the first term in the numerator of (A.72) is positive if

$$\xi \geq \xi_c \equiv \left(\frac{\phi_d}{\phi_d + \phi_f} \right) (1 - \phi_d - \phi_f). \quad (\text{A.73})$$

In addition, recall that $0 \leq \xi \leq (1 - \phi_d - \phi_f)$ by assumption. Thus, $(1-\delta)\rho$ is unambiguously increasing in $\sigma^* \forall r$ in situations where $\xi \in [\xi_c, (1 - \phi_d - \phi_f))$ holds and a currency board is in place. As a consequence, $\tilde{k}$ is decreasing (increasing) in σ^* if Case 1 (Case 2) obtains or, equivalently if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$.

On the other hand, notice that if $\xi \in (0, \xi_c)$, the first term in the numerator of (A.72) is negative and, obviously, $\frac{\partial[(1-\delta)\rho]}{\partial\sigma^*}$ is decreasing in r . Also, while the denominator in (A.72) is always positive, we can rewrite the numerator as

$$(\phi_d + \phi_f)(1 - \phi_d - \phi_f - \xi) - r[\phi_d - (\phi_d + \phi_f)(\phi_d + \xi)] \quad (\text{A.74})$$

and, therefore

$$\frac{\partial[(1-\delta)\rho]}{\partial\sigma^*} > 0 \Leftrightarrow r < r_c \equiv \frac{(\phi_d + \phi_f)(1 - \phi_d - \phi_f - \xi)}{[\phi_d - (\phi_d + \phi_f)(\phi_d + \xi)]} \quad (\text{A.75})$$

under a currency board when $\xi \in (0, \xi_c)$. However, r_c seems to be arbitrarily high for parameter values similar to the ones found in Latin American countries and, therefore, it

seems that $r < r_c$ always holds. Therefore, under plausible conditions, $(1-\delta)\rho$ is also an increasing function of σ^* when $\xi \in (0, \xi_c)$ and, as a consequence, $\tilde{k}$ is decreasing (increasing) in σ^* if Case 1 (Case2) obtains or, equivalently if $r(1-\lambda)(1-\alpha) < (>) \alpha\pi$.

Next, I proceed to analyze the effects of increases in σ^* on the share of net investment abroad in total savings, $\tilde{\chi}$. Differentiating equation (69) in Chapter I, I am able to determine that

$$\begin{aligned} \frac{\partial \tilde{\chi}}{\partial \sigma^*} = & \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda(1-\alpha)(1-\phi_d - \phi_f)[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \\ & \times \left\{ (1-\pi)x \frac{\partial \delta}{\partial \sigma^*} - \pi(1-\delta)^2 \frac{\partial \rho}{\partial \sigma^*} \right\}. \end{aligned} \quad (\text{A.76})$$

Using (A.41) and (A.44), (A.76) can be rewritten as

$$\begin{aligned} \frac{\partial \tilde{\chi}}{\partial \sigma^*} = & \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda(1-\alpha)[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \\ & \times \left\{ \frac{(1-\pi)x\phi_d - \pi(\phi_d + \phi_f)}{[(1+\sigma^*)(r-1)(\theta\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2} \right\}. \end{aligned} \quad (\text{A.77})$$

Obviously, under a currency board $\theta=1$ and $\xi \in [0, (1-\phi_d-\phi_f))$, and therefore (A.77) can be rewritten as

$$\begin{aligned} \frac{\partial \tilde{\chi}}{\partial \sigma^*} = & \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda(1-\alpha)[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \\ & \times \left\{ \frac{(1-\pi)x\phi_d - \pi(\phi_d + \phi_f)}{[(1+\sigma^*)(r-1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2} \right\}. \end{aligned} \quad (\text{A.78})$$

Define $x_c \equiv \left(\frac{\pi}{1-\pi} \right) \left(\frac{\phi_d + \phi_f}{\phi_d} \right)$. Then $\left. \frac{\partial \tilde{\chi}}{\partial \sigma^*} \right|_{x=x_c} = 0$. Moreover, when Case 1

obtains

$$\frac{\partial \tilde{\chi}}{\partial \sigma^*} = \begin{cases} > 0, \text{ if } x < x_c \\ < 0, \text{ if } x > x_c \end{cases}, \quad (\text{A.79})$$

while when Case 2 obtains

$$\frac{\partial \tilde{\chi}}{\partial \sigma^*} = \begin{cases} < 0, \text{ if } x < x_c \\ > 0, \text{ if } x > x_c \end{cases}. \quad (\text{A.80})$$

I now analyze when each of the conditions in (A.79) and (A.80) holds, respectively.

Notice that, under a currency board

$$\lim_{\sigma^* \rightarrow \infty} (1-\delta)\rho = \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)}. \quad (\text{A.81})$$

Also notice that if Case 1 (Case 2) obtains

$$\left(\frac{1-\pi}{\pi} \right) x < (>) \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)} \quad (\text{A.82})$$

for $\lim_{\sigma^* \rightarrow \infty} f'(\tilde{k})$ to be well-defined. Next, I start by analyzing situations where $\xi \in [0, \xi_c)$.

Recall that, under these circumstances, $[\phi_d - (\phi_d + \phi_f)(\phi_d + \xi)] > 0$ holds. If this is the case, it is straightforward to show that

$$\lim_{\sigma^* \rightarrow \infty} (1-\delta)\rho = \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)} < \frac{(\phi_d + \phi_f)}{\phi_d} \Leftrightarrow r < r_c. \quad (\text{A.83})$$

Notice that when Case 1 obtains

$$\left(\frac{1-\pi}{\pi}\right)x > \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)} < \left(\frac{\phi_d + \phi_f}{\phi_d}\right) \Rightarrow x < x_c. \quad (\text{A.84})$$

Thus, when Case 1 obtains and when both $\xi \in [0, \xi_c)$ and $r < r_c$ hold, $\tilde{\chi}$ is always an increasing function of σ^* . On the other hand, notice that when Case 2 obtains and when both $\xi \in [0, \xi_c)$ and $r < r_c$ hold,

$$\left(\frac{1-\pi}{\pi}\right)x > \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)}, \quad (\text{A.85})$$

but (A.83) holds too. Therefore, it is possible to observe either $x < x_c$ or $x > x_c$ and, then, from (A.80), $\tilde{\chi}$ will be decreasing or increasing in σ^* , accordingly.

Regarding situations where $\xi \in [\xi_c, (1-\phi_d - \phi_f))$, I focus again, for consistency, on the case where $r < r_c$. It is straightforward to show that

$$\lim_{\sigma^* \rightarrow \infty} (1-\delta)\rho = \frac{r}{(r-1)(\phi_d + \xi) + (1-\phi_f)} \Leftrightarrow r < r_c, \quad (\text{A.86})$$

since $[\phi_d - (\phi_d + \phi_f)(\phi_d + \xi)] < 0$ when $\xi \in [\xi_c, (1-\phi_d - \phi_f))$. Using (A.82) and (A.86), it is possible to determine that either $x < x_c$ or $x > x_c$ when Case 1 obtains and both $\xi \in [\xi_c, (1-\phi_d - \phi_f))$ and $r < r_c$ hold. Thus, $\tilde{\chi}$ will be increasing or decreasing in σ^* accordingly. On the other hand, using also (A.82) and (A.86), it is possible to determine that $x > x_c$ when Case 2 obtains and both $\xi \in [\xi_c, (1-\phi_d - \phi_f))$ and $r < r_c$ hold. Thus, under these circumstances, $\tilde{\chi}$ is always increasing in σ^* . Q.E.D.

Effects of Increases in r on $\tilde{k}$ and $\tilde{\chi}$ I start with the analysis of the effects of increases in r on $\tilde{k}$. Differentiating equation (68) in Chapter I with respect to r , I obtain

$$\frac{\partial \tilde{k}}{\partial r} = \frac{\tilde{k}^{2-\alpha} \left\{ \pi [r(1-\lambda)(1-\alpha) - \alpha\pi] \left[(1-\delta) \frac{\partial \rho}{\partial r} - \rho \frac{\partial \delta}{\partial r} \right] + [(1-\pi)x - \pi(1-\delta)\rho] \right\}}{\{(1-\alpha)A[r(1-\lambda)(1-\alpha) - \alpha\pi]^2\}}. \quad (\text{A.87})$$

Using (A.42) and (A.47) I obtain

$$(1-\delta) \frac{\partial \rho}{\partial r} - \rho \frac{\partial \delta}{\partial r} = \frac{(1+\sigma^*)[(1-\phi_d - \phi_f)(1-\phi_d - \xi) + \sigma^*(1-\phi_d - \phi_f - \xi)]}{[(1+\sigma^*)(r-1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2}. \quad (\text{A.88})$$

Notice that (A.88) is unambiguously positive $\forall \sigma^* > -\frac{(1-\phi_d - \phi_f)(1-\phi_d - \xi)}{(1-\phi_d - \phi_f - \xi)}$.

Also, recall that both domestic and foreign currency being dominated in rates of return implies that $\sigma^* > \left(\frac{1}{r} - 1\right)$. Also, under a currency board, $\left(\frac{1}{r} - 1\right) > \sigma_\delta^*$, unambiguously. If

$\left(\frac{1}{r} - 1\right) > -\frac{(1-\phi_d - \phi_f)(1-\phi_d - \xi)}{(1-\phi_d - \phi_f - \xi)}$, then $(1-\delta)\rho$ is always increasing in r . I next proceed

to analyze when the last condition holds.

$$\begin{aligned} \left(\frac{1}{r} - 1\right) &> -\frac{(1-\phi_d - \phi_f)(1-\phi_d - \xi)}{(1-\phi_d - \phi_f - \xi)} \\ \Leftrightarrow \left(\frac{1}{r}\right) &> \frac{[\phi_d(1-\phi_d - \phi_f) - (\phi_d + \phi_f)\xi]}{(1-\phi_d - \phi_f - \xi)}. \end{aligned} \quad (\text{A.89})$$

Obviously, if $\xi \in [\xi_c, (1-\phi_d - \phi_f))$, the right-hand-side of the second inequality in (A.89) is negative, and the inequality always holds, resulting in $(1-\delta)\rho$ being always

increasing in r . On the other hand, if $\xi \in [0, \xi_c)$, the right-hand-side of the second inequality is positive. In this case, it is helpful to rewrite the second inequality in (A.89) as

$$r < \frac{(1 - \phi_d - \phi_f - \xi)}{[\phi_d(1 - \phi_d - \phi_f) - (\phi_d + \phi_f)\xi]}. \quad (\text{A.90})$$

Notice that, given that both $r > 1$ and $\frac{(1 - \phi_d - \phi_f - \xi)}{[\phi_d(1 - \phi_d - \phi_f) - (\phi_d + \phi_f)\xi]} > 1$, (A.90) might hold (or not), especially if ξ is very close to ξ_c . Thus, when $\xi \in [0, \xi_c)$, $(1 - \delta)\rho$ is increasing in r for all values of σ^* but maybe those arbitrarily close to $\left(\frac{1}{r} - 1\right)$. I can then say that $(1 - \delta)\rho$ is typically increasing in r , $\forall \xi \in [0, (1 - \phi_d - \phi_f))$, $\forall \sigma^* > \text{Max}\left\{\left(\frac{1}{r} - 1\right)\sigma_\delta^*\right\}$.

Now, I return to the analysis of equation (A.87). When Case 1 (Case 2) obtains, both $r(1 - \lambda)(1 - \alpha) < (>) \alpha\pi$ and $[(1 - \pi)x - \pi(1 - \delta)\rho] < (>) 0$ hold, and, therefore, $\tilde{k}$ is decreasing (increasing) in r , given that, as we have previously proved, $(1 - \delta)\rho$ is typically increasing in r .

Next, I analyze the effects of increases in r on the share of net investment abroad in total savings. Differentiating equation (69) in Chapter I with respect to r , I obtain

$$\frac{\partial \tilde{\chi}}{\partial r} = \frac{\left[(\delta - 1)(1 - \alpha) \tilde{k}^{-\alpha} \frac{\partial \tilde{k}}{\partial r} + \tilde{k}^{1-\alpha} \frac{\partial \delta}{\partial r} \right]}{\lambda A(1 - \alpha)(1 - \phi_d - \phi_f)}. \quad (\text{A.91})$$

Using (A.47) and the previous result, it should be obvious that when Case 1 obtains and a currency board is in place, $\frac{\partial \tilde{\chi}}{\partial r} > 0$. However, when Case 2 obtains and a currency board is in place, both $\tilde{k}$ and δ are increasing in r , resulting in two forces that act in opposite directions. In this case, it is helpful to rewrite (A.91) as

$$\frac{\partial \tilde{\chi}}{\partial r} = \frac{\text{Term1} + \text{Term2} + \text{Term3}}{\lambda A(1 - \alpha)(1 - \phi_d - \phi_f) [(1 - \pi)x - \pi(1 - \delta)\rho]^2}, \quad (\text{A.92})$$

where

$$\text{Term1} \equiv (\delta - 1) [(1 - \pi)x - \pi(1 - \delta)\rho] < 0 \quad \text{when Case 2 obtains,} \quad (\text{A.93})$$

$$\text{Term2} \equiv [(1 - \pi)x - \pi(1 - \delta)\rho] [r(1 - \lambda)(1 - \alpha) - \alpha\pi] \frac{\partial \delta}{\partial r} > 0 \quad (\text{A.94})$$

when either Case 1 or Case 2 obtain,

$$\text{Term3} \equiv (\delta - 1) [r(1 - \lambda)(1 - \alpha) - \alpha\pi] \pi \left\{ \frac{\partial [(1 - \delta)\rho]}{\partial r} \right\} < 0 \quad (\text{A.95})$$

when Case 2 obtains

Thus, the effect of increases in r on $\tilde{\chi}$ is ambiguous when Case 2 obtains and a currency board is in place.

Effects of Increases in ϕ_d on $\tilde{k}$ and $\tilde{\chi}$ I start with the analysis of the effects of increases in ϕ_d on the capital-labor ratio, $\tilde{k}$. Differentiating equation (68) in Chapter I with respect to ϕ_d , I obtain

$$\frac{\partial \tilde{k}}{\partial \phi_d} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left\{ \frac{\partial[(1-\delta)\rho]}{\partial \phi_d} \right\}. \quad (\text{A.96})$$

Using (A.43) and (A.49), I am able to determine that

$$\begin{aligned} \frac{\partial[(1-\delta)\rho]}{\partial \phi_d} = & \frac{[r(1+\sigma^*) - 1][(1+\sigma^*)(r1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]}{(1-\phi_d - \phi_f)[(1+\sigma^*)(r1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2} \\ & - \frac{[r(1+\sigma^*) - (\phi_d + \phi_f)][(1+\sigma^*)(r-1)(1-\phi_d - \xi) + \sigma^*(1-\phi_f)]}{(1-\phi_d - \phi_f)[(1+\sigma^*)(r1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2}. \end{aligned} \quad (\text{A.97})$$

After some simplifications, (A.97) can be rewritten as

$$\frac{\partial[(1-\delta)\rho]}{\partial \phi_d} = \frac{\Theta_1 - \Theta_2}{(1-\phi_d - \phi_f)\Theta_3} >< 0, \quad (\text{A.98})$$

where

$$\Theta_1 \equiv \sigma^*[(r-1) + r^2(\phi_f - \xi) + \xi], \quad (\text{A.99})$$

$$\Theta_2 \equiv r(r-1)(1+\sigma^*)^2 + (r-1)[1 + (\phi_f)(r+1)], \quad (\text{A.100})$$

and

$$\Theta_3 \equiv [(1+\sigma^*)(r-1)(\phi_d + \xi) + (1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2 \quad (\text{A.101})$$

Therefore, the effect of increases in ϕ_d on the capital-labor ratio $\tilde{k}$ is always (both when Case 1 or Case 2 obtain) ambiguous when a currency board is in place.

Now I turn to the analysis of the effects of increases in ϕ_d on $\tilde{\chi}$ under a currency board. Differentiating equation (69) in Chapter I with respect to ϕ_d , I obtain the following expression

$$\frac{\partial \tilde{\chi}}{\partial \phi_d} = \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda A(1-\alpha)} \right\} \left\{ \frac{\Lambda_1 + \Lambda_2 + \Lambda_3}{(1-\phi_d - \phi_f)^2 [(1-\pi)x - \pi(1-\delta)\rho]^2} \right\}, \quad (\text{A.102})$$

where

$$\Lambda_1 \equiv (1-\phi_d - \phi_f)[(1-\pi)x - \pi(1-\delta)\rho] \frac{\partial \delta}{\partial \phi_d} = \begin{cases} < 0, \text{ if Case 1 obtains} \\ > 0, \text{ if Case 2 obtains} \end{cases}, \quad (\text{A.103})$$

$$\Lambda_2 \equiv (\delta - 1)[(1-\pi)x - \pi(1-\delta)\rho] = \begin{cases} > 0, \text{ if Case 1 obtains} \\ < 0, \text{ if Case 2 obtains} \end{cases}, \quad (\text{A.104})$$

and,

$$\Lambda_3 \equiv (\delta - 1)(1-\phi_d - \phi_f)\pi \frac{\partial [(1-\delta)\rho]}{\partial \phi_d} < 0 \quad \text{in either Case 1 or Case 2.} \quad (\text{A.105})$$

Therefore, the effect of increases in ϕ_d on the share of net investment abroad, $\tilde{\chi}$, are ambiguous for either Case 1 or Case 2 under a currency board.

Effects of Increases in ϕ_f on $\tilde{k}$ and $\tilde{\chi}$ I first analyze the effects of increases in ϕ_f on the capital-labor ratio, $\tilde{k}$. Differentiating equation (68) in Chapter I with respect to ϕ_f , I obtain the following expression

$$\frac{\partial \tilde{k}}{\partial \phi_f} = \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{A(1-\alpha)[r(1-\lambda)(1-\alpha) - \alpha\pi]} \right\} \left\{ \frac{\partial [(1-\delta)\rho]}{\partial \phi_f} \right\}. \quad (\text{A.106})$$

Using (A.53) as well as (A.43), I am able to determine that

$$\frac{\partial[(1-\delta)\rho]}{\partial\phi_f} = \frac{r(1+\sigma^*)^2 + \sigma^* [1 + \phi_f - (r-1)(\phi_d + \xi)] + [1 - (r-1)(\phi_d + \xi)]}{(1-\phi_d - \phi_f)\Theta_3} > 0. \quad (\text{A.107})$$

Thus, when Case 1 (Case 2) obtains, and a currency board is in place, the capital-labor ratio $\tilde{k}$ is decreasing (increasing) in ϕ_f .

Next, I turn to the analysis of the effects of increases in ϕ_f on the share of net investment abroad, $\tilde{\chi}$. Differentiating equation (69) in Chapter I with respect to ϕ_f , I obtain

$$\frac{\partial\tilde{\chi}}{\partial\phi_f} = \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda A(1-\alpha)} \right\} \left\{ \frac{\Lambda'_1 + \Lambda'_2 + \Lambda'_3}{(1-\phi_d - \phi_f)^2 [(1-\pi)x - \pi(1-\delta)\rho]^2} \right\}, \quad (\text{A.108})$$

where

$$\Lambda'_1 \equiv (1-\phi_d - \phi_f)[(1-\pi)x - \pi(1-\delta)\rho] \frac{\partial\delta}{\partial\phi_f} = \begin{cases} < 0, & \text{if Case 1 obtains} \\ > 0, & \text{if Case 2 obtains} \end{cases}, \quad (\text{A.109})$$

$$\Lambda'_2 \equiv (\delta - 1)[(1-\pi)x - \pi(1-\delta)\rho] = \begin{cases} > 0, & \text{if Case 1 obtains} \\ < 0, & \text{if Case 2 obtains} \end{cases}, \quad (\text{A.110})$$

and

$$\Lambda'_3 \equiv (\delta - 1)(1-\phi_d - \phi_f)\pi \frac{\partial[(1-\delta)\rho]}{\partial\phi_f} < 0 \text{ in either Case Case 2.} \quad (\text{A.111})$$

Thus, when a currency board is in operation and either Case 1 or Case 2 obtain, increases in ϕ_f have ambiguous effects on the share of net investment abroad, $\tilde{\chi}$.

3.2.3 Comparative Statics under a Pure Fixed Exchange Rate

Effects of increases in σ^* on $\tilde{k}$ and $\tilde{\chi}$ I start with the analysis of the effects of increases in σ^* on $\tilde{k}$. The steps are identical to the ones followed for the case of a currency board. Equation (A.70) still applies. However, using $\theta=\xi=0$ in (A.71), I obtain

$$\frac{\partial[(1-\delta)\rho]}{\partial\sigma^*} = \frac{-r\phi_d + (\phi_d + \phi_f)(1-\phi_f)}{[(1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2}, \quad (\text{A.112})$$

and, therefore

$$\frac{\partial[(1-\delta)\rho]}{\partial\sigma^*} > 0 \Leftrightarrow r < r_c \equiv \left(\frac{\phi_d + \phi_f}{\phi_d} \right) (1 - \phi_f). \quad (\text{A.113})$$

It follows from both (A.70) and (A.113) that when $r < r_c$ and Case 1 (Case 2) obtains, the capital-labor ratio $\tilde{k}$ is decreasing (increasing) in σ^* .

I next turn to the analysis of the effects of increases in σ^* on the share of net investment abroad, $\tilde{\chi}$. Equation (A.77) still applies, and using the fact that under a pure fixed exchange rate regime $\theta=\xi=0$, I obtain

$$\frac{\partial\tilde{\chi}}{\partial\sigma^*} = \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda(1-\alpha)[(1-\pi)x - \pi(1-\delta)\rho]^2} \right\} \left\{ \frac{(1-\pi)x\phi_d - \pi(\phi_d + \phi_f)}{[(1-\phi_d - \phi_f) + \sigma^*(1-\phi_f)]^2} \right\}. \quad (\text{A.114})$$

Recall that I have previously defined $x_c \equiv \left(\frac{\pi}{1-\pi} \right) \left(\frac{\phi_d + \phi_f}{\phi_f} \right)$ and that $\frac{\partial\tilde{\chi}}{\partial\sigma^*} = 0$

when $x=x_c$. Then, when Case 1 obtains (A.79) holds, while when Case 2 obtains (A.80) holds. Now, I turn to analyze the conditions under which (A.79) and (A.80), respectively,

hold. Again, I focus on situations where $r < r_c$. Notice that under a pure fixed exchange rate regime

$$\lim_{\sigma^* \rightarrow \infty} (1 - \delta)\rho = \frac{r}{(1 - \phi_d)}. \quad (\text{A.115})$$

In addition, for $\lim_{\sigma^* \rightarrow \infty} f'(\tilde{k})$ to be well-defined, when Case 1 (Case 2) obtains

$$\left(\frac{1 - \pi}{\pi} \right) x < (>) \frac{r}{(1 - \phi_d)} \quad (\text{A.116})$$

must hold. It is straightforward to show that

$$\lim_{\sigma^* \rightarrow \infty} (1 - \delta)\rho = \frac{r}{(1 - \phi_f)} < \left(\frac{\phi_d + \phi_f}{\phi_d} \right) \Leftrightarrow r < r_c. \quad (\text{A.117})$$

Notice that when Case 1 obtains,

$$\left(\frac{1 - \pi}{\pi} \right) x < \frac{r}{(1 - \phi_f)} < \frac{(\phi_d + \phi_f)}{\phi_f} \Rightarrow x < x_c. \quad (\text{A.118})$$

Therefore, when Case 1 obtains and there is a pure fixed exchange rate regime in place, $\tilde{\chi}$ is increasing in σ^* . On the other hand, when Case 2 obtains

$$\left(\frac{1 - \pi}{\pi} \right) x > \frac{r}{(1 - \phi_d)}, \quad (\text{A.119})$$

but also (A.117) holds. Then, when Case 2 obtains and a pure fixed exchange rate regime is in place, either $x < x_c$ or $x > x_c$ may be observed and, thus, $\tilde{\chi}$ can be either decreasing or increasing in σ^* , respectively.

Effects of Increases in r on $\tilde{k}$ and $\tilde{\chi}$ I start with the analysis of the effects of increases in r on $\tilde{k}$. Recall that, by differentiating equation (68) in Chapter I with respect to r , I obtained equation (A.87), which still holds. Using (A.42) as well as the fact that $\frac{\partial \delta}{\partial r} = 0$ under a pure fixed exchange rate regime, I obtain

$$\begin{aligned} \frac{\partial \tilde{k}}{\partial r} &= \tilde{k}^{2-\alpha} \left\{ \frac{\pi[r(1-\lambda)(1-\alpha) - \alpha\pi](1-\delta)\frac{\partial \rho}{\partial r} + [(1-\pi)\chi - \pi(1-\delta)\rho]}{(1-\alpha)A[r(1-\lambda)(1-\alpha) - \alpha\pi]^2} \right\} \\ &= \begin{cases} < 0, \text{ if Case 1 obtains} \\ > 0, \text{ if Case 2 obtains} \end{cases} \end{aligned} \quad (\text{A.120})$$

Thus, when Case 1 (Case 2) obtains and a pure fixed exchange rate regime is in place, the capital-labor ratio $\tilde{k}$ is decreasing (increasing) in r .

I next turn to the analysis of the effects of increases in r on the share of net investment abroad $\tilde{\chi}$. Differentiating equation (69) in Chapter I and, again, using the fact that $\frac{\partial \delta}{\partial r} = 0$ under a pure fixed exchange rate regime, I obtain

$$\frac{\partial \tilde{\chi}}{\partial r} = \frac{\left[(\delta - 1)(1 - \alpha)\tilde{k}^{-\alpha} \frac{\partial \tilde{k}}{\partial r} \right]}{\lambda A(1 - \alpha)(1 - \phi_d - \phi_f)} = \begin{cases} > 0, \text{ if Case 1 obtains} \\ < 0, \text{ if Case 2 obtains} \end{cases} \quad (\text{A.121})$$

Thus, when Case 1 (Case 2) obtains, $\tilde{\chi}$ is increasing (decreasing) in r .

Effects of Increases in ϕ_d on $\tilde{k}$ and $\tilde{\chi}$ I start with the analysis of the effects of increases in ϕ_d on $\tilde{k}$, the capital-labor ratio when credit is rationed. Differentiating equation (68) in Chapter I with respect to ϕ_d and using the fact that $\theta=\xi=0$ under a pure fixed exchange rate regime, I obtain

$$\begin{aligned}\frac{\partial \tilde{k}}{\partial \phi_d} &= \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{(1-\alpha)A[r(1-\lambda)(1-\alpha)-\alpha\pi]} \right\} \left\{ \frac{\partial[(1-\delta)\rho]}{\partial \phi_d} \right\} \quad (\text{A.122}) \\ &= \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{(1-\alpha)A[r(1-\lambda)(1-\alpha)-\alpha\pi]} \right\} \left\{ \frac{(r-1)+\sigma^*(r-1+\phi_d)}{[(1-\phi_d-\phi_f)+\sigma^*(1-\phi_f)]^2} \right\}.\end{aligned}$$

Notice that $\frac{\partial[(1-\delta)\rho]}{\partial \phi_d} > 0, \forall \sigma^* > \left(\frac{1}{r}-1\right)$. Thus, when Case 1 (Case 2) obtains

and a pure fixed exchange rate regime is in place, $\tilde{k}$ is decreasing (increasing) in ϕ_d .

Now, I turn to the analysis of the effects of increases in ϕ_d on the share of net investment abroad $\tilde{\chi}$. Differentiating equation (69) in Chapter I with respect to ϕ_d , and again using the fact that $\theta=\xi=0$, I obtain

$$\frac{\partial \tilde{\chi}}{\partial \phi_d} = \left\{ \frac{[r(1-\lambda)(1-\alpha)-\alpha\pi]}{\lambda A(1-\alpha)} \right\} \left\{ \frac{\Delta_1 + \Delta_2}{[(1-\phi_d-\phi_f)^2[(1-\pi)x-\pi(1-\delta)\rho]^2]} \right\}, \quad (\text{A.123})$$

where

$$\begin{aligned}\Delta_1 &\equiv -\frac{[(1-\pi)x-\pi(1-\delta)\rho](1-\phi_d-\phi_f)^2(1+\sigma^*)}{[(1-\phi_d-\phi_f)+\sigma^*(1-\phi_f)]^2} \quad (\text{A.124}) \\ &= \begin{cases} > 0, \text{ if Case 1 obtains} \\ < 0, \text{ if Case 2 obtains} \end{cases}\end{aligned}$$

and

$$\Delta_2 \equiv -\frac{(1+\sigma^*)(1-\phi_d-\phi_f)^2\pi[(r-1)+\sigma^*(r-1+\phi_f)]}{[(1-\phi_d-\phi_f)+\sigma^*(1-\phi_f)]^2} < 0, \forall \sigma^* > \left(\frac{1}{r}-1\right) \quad (\text{A.125})$$

Thus, when Case 1 obtains and a pure fixed exchange rate regime is in place, increases in ϕ_d have ambiguous effects on the share of net investment abroad in total savings, $\tilde{\chi}$. However, when Case 2 obtains, $\tilde{\chi}$ is decreasing in ϕ_d .

Effects of Increases in ϕ_f on $\tilde{k}$ and $\tilde{\chi}$ Again, I start with the analysis of the effects of increases in ϕ_f on the capital-labor ratio $\tilde{k}$. Differentiating equation (68) in Chapter I with respect to ϕ_f and using the fact that $\theta=\xi=0$ under a pure fixed exchange rate regime, I obtain

$$\begin{aligned} \frac{\partial \tilde{k}}{\partial \phi_f} &= \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{(1-\alpha)A[r(1-\lambda)(1-\alpha)-\alpha\pi]} \right\} \left[\frac{\partial[(1-\delta)\rho]}{\partial \phi_f} \right] \quad (\text{A.126}) \\ &= \left\{ \frac{\pi \tilde{k}^{2-\alpha}}{(1-\alpha)A[r(1-\lambda)(1-\alpha)-\alpha\pi]} \right\} \left[\frac{r(1+\sigma^*)^2 - [1+\sigma^*(1+\phi_d)]}{[(1-\phi_d-\phi_f)+\sigma^*(1-\phi_f)]^2} \right] \end{aligned}$$

Notice that $\frac{\partial[(1-\delta)\rho]}{\partial \phi_f} > 0, \forall \sigma^* > \left(\frac{1}{r}-1\right)$. Thus, when Case 1 (Case 2) obtains

and a pure fixed exchange rate regime is in place, $\tilde{k}$ is decreasing (increasing) in ϕ_f .

Next, I turn to the analysis of the effects of increases in ϕ_f on the share of net investment abroad $\tilde{\chi}$. Differentiating equation (69) in Chapter I with respect to ϕ_f , and again using the fact that $\theta=\xi=0$, I obtain

$$\frac{\partial \tilde{\chi}}{\partial \phi_f} = \left\{ \frac{[r(1-\lambda)(1-\alpha) - \alpha\pi]}{\lambda A(1-\alpha)} \right\} \left\{ \frac{\Delta'_1 + \Delta'_2}{(1-\phi_d - \phi_f)^2 [(1-\pi)x - \pi(1-\delta)\rho]^2} \right\}, \quad (\text{A.127})$$

where

$$\Delta'_1 \equiv - \frac{(1-\phi_d - \phi_f)^2 (1+\sigma^*)^2 [(1-\pi)x - \pi(1-\delta)\rho]}{[(1-\phi_d - \phi_f) + \sigma^* (1-\phi_f)]^2} \quad (\text{A.128})$$

and

$$\Delta'_2 \equiv \frac{(\delta-1)(1-\phi_d - \phi_f)\pi \{r(1+\sigma^*)^2 - [1 + \sigma^* (1+\phi_d)]\}}{[(1-\phi_d - \phi_f) + \sigma^* (1-\phi_f)]^2} < 0, \forall \sigma^* > \left(\frac{1}{r} - 1\right) \quad (\text{A.129})$$

Thus, when Case 1 obtains and a pure fixed exchange rate regime is in place, the effect of increases in ϕ_f on $\tilde{\chi}$ is ambiguous. However, when Case 2 obtains and a pure fixed exchange rate regime is in place, $\tilde{\chi}$ is decreasing in ϕ_f .

3.3 When Does Credit Rationing Occur?

I start this section by proving Lemmas 10 and 11.

Lemma 10. *The steady-state interest rate on loans is a monotonically increasing and concave function of the steady-state inflation rate in the rest of the world, for any $\sigma^* > \text{Max}\left\{\sigma_\delta^*, \left(\frac{1}{r} - 1\right)\right\}$, and it is bounded above. These properties do not depend upon how the domestic money supply is backed in a fixed exchange rate regime.*

Proof. (A.41) implies that the steady-state interest rate on loans is monotonically increasing in σ^* . In addition, differentiating (A.41) with respect to σ^* , I obtain

$$\frac{\partial^2 \rho}{\partial (\sigma^*)^2} = - \frac{2(\phi_d + \phi_f)}{(1 - \phi_f - \phi_f)(1 + \sigma^*)^3} < 0. \quad (\text{A.130})$$

Both (A.41) and (A.130), as well as

$$0 < \lim_{\sigma^* \rightarrow \infty} \rho = \frac{r}{(1 - \phi_d - \phi_f)} < \infty \quad (\text{A.131})$$

imply that the steady-state interest rate on loans is bounded above. In addition, by inspection of equation of equation (62) in Chapter I, it is straightforward to deduct that ρ is independent of the policy parameters θ and ξ . Thus, the properties of ρ do not depend upon how the domestic money supply is backed in a fixed exchange rate regime. Q.E.D.

Lemma 11. *If $r < r_c$, then $(1 - \delta)\rho$ is an increasing function of the steady-state inflation rate in the rest of the world, for any $\sigma^* > \text{Max}\left\{\sigma_\delta^*, \left(\frac{1}{r} - 1\right)\right\}$. This property does not depend upon how the domestic money supply is backed in a fixed exchange rate regime.*

Proof. (A.72), (A.75) and (A.113) prove this lemma. Q.E.D.

Next, I turn to the analysis of when does credit rationing occur for the different parameter configurations considered, i.e., for Case 1 and Case 2, respectively.

3.3.1 Case 1

Using condition (71) in Chapter I, credit is rationed when Case 1 obtains if

$$\alpha[(1-\pi)x - \pi(1-\delta)\rho] < [r(1-\lambda)(1-\alpha) - \alpha\pi]\rho. \quad (\text{A.132})$$

From Lemmas 10 and 11 we know that ρ and $(1-\delta)\rho$ are both increasing in σ^* . In addition, both $[(1-\pi)x - \pi(1-\delta)\rho] < 0$ and $[r(1-\lambda)(1-\alpha) - \alpha\pi] < 0$ when Case 1 obtains. Therefore both the left-hand side and the right-hand side of (A.132) are negative and decreasing in σ^* . Thus, the correspondence between the presence of credit rationing and the foreign (and domestic) rate of inflation may be relatively complicated.

3.3.2 Case 2

Using condition (71) in Chapter I, credit is rationed when Case 2 obtains if

$$\alpha[(1-\pi)x - \pi(1-\delta)\rho] > [r(1-\lambda)(1-\alpha) - \alpha\pi]\rho. \quad (\text{A.133})$$

Again, from Lemmas 10 and 11 we know that ρ and $(1-\delta)\rho$ are both increasing in σ^* . In addition, both $[(1-\pi)x - \pi(1-\delta)\rho] > 0$ and $[r(1-\lambda)(1-\alpha) - \alpha\pi] > 0$ when Case 2 obtains. Then, both the left-hand side and the right-hand side of (A.133) are positive. However, the left-hand side of (A.133) is decreasing in σ^* while the right-hand side is increasing in σ^* . Thus, if (A.133) holds or, equivalently, if credit rationing occurs, it will be observed for low foreign (and domestic) inflation rates.

4 Technical Notes on the Local Stability Analysis in Section 3

4.1 The Dynamical System in a Walrasian Regime

Using equations (61) and (75) in Chapter I, I obtain

$$\frac{\partial \tau_t}{\partial \tau_{t-1}} = -G_2 = -\frac{(1+\sigma^*)r(\theta\phi_d + \xi) - \phi_d}{(1-\theta\phi_d - \phi_f - \xi)(1+\sigma^*)}. \quad (\text{A.134})$$

Next, I analyze local stability under a currency board and a pure fixed exchange rate, respectively.

4.1.1 Local Stability under a Currency Board

Notice that, under a currency board, given that $\theta=1$ and $\xi \in [0, (1-\phi_d-\phi_f))$, we can rewrite (A.134) as

$$\left. \frac{\partial \tau_t}{\partial \tau_{t-1}} \right|_{(\theta=1, \xi)} = -G_2(\theta=1, \xi) = -\frac{(1+\sigma^*)r(\phi_d + \xi) - \phi_d}{(1-\phi_d - \phi_f - \xi)(1+\sigma^*)}. \quad (\text{A.135})$$

Notice that $G_2 > 0, \forall \sigma^* > \left(\frac{1}{r} - 1\right)$ and, therefore $\frac{\partial \tau_t}{\partial \tau_{t-1}} < 0$ under a currency board. Also notice that $\frac{\partial G_2}{\partial \sigma^*} > 0$, and therefore, local stability might depend on the foreign (and domestic) rate of inflation.

If $G_2 > 1$, then the solution to (75) in Chapter I is stable, but fluctuations will be observed. Notice, from (A.135), that

$$\text{If } r > \frac{(1-\phi_d - \phi_f - \xi)}{\xi} \Rightarrow G_2 > 1, \forall \sigma^* > \left(\frac{1}{r} - 1\right) \quad (\text{A.136})$$

On the other hand,

$$\text{If } r < \frac{(1-\phi_d - \phi_f - \xi)}{\xi} \Rightarrow \begin{cases} G_2 > 1, \text{ for } \sigma^* < a \\ G_2 < 1, \text{ for } \sigma^* > a \end{cases}, \quad (\text{A.137})$$

where

$$a \equiv \frac{\phi_d + (1-\phi_f) - (r+1)(\phi_d + \xi)}{(r+1)(\phi_d + \xi) - (1-\phi_f)}. \quad (\text{A.138})$$

Thus, when a currency board is in place, it is possible to observe either $\left| \frac{\partial \tau_t}{\partial \tau_{t-1}} \right| > 1$ or $\left| \frac{\partial \tau_t}{\partial \tau_{t-1}} \right| < 1$. Finally, from equations (75) and (76) in Chapter I, it can be easily inferred that any fluctuations observed in the government's fiscal position (τ_t) will be transmitted to net investment abroad.

4.1.2 Local Stability under a Pure Fixed Exchange Rate Regime

Under a pure fixed exchange rate, given that $\theta = \xi = 0$, we can rewrite (A.134) as

$$\left. \frac{\partial \tau_t}{\partial \tau_{t-1}} \right|_{(\theta=\xi=0)} = -G_2(\theta = \xi = 0) = \frac{\phi_d}{(1 - \phi_f)(1 + \sigma^*)} > 0, \forall \sigma^* > \left(\frac{1}{r} - 1 \right) \quad (\text{A.139})$$

Also notice that $\frac{\partial(-G_2)}{\partial \sigma^*} < 0$ and, therefore, as σ^* increases, the solution to (75) in

Chapter I becomes more unstable when a pure fixed exchange rate regime is in place.

Finally, notice that $|G_2| < 1, \forall \sigma^* > \text{Max} \left\{ \sigma_\delta^*, \left(\frac{1}{r} - 1 \right) \right\}$. Therefore, the solution to (75) in

Chapter I is typically unstable under a pure fixed exchange rate regime, but no oscillations are observed.

4.2 The Dynamical System in a Credit Rationing Regime

4.2.1 Determinant of the Jacobian evaluated at the nontrivial steady-state

Recall that the Jacobian of the linearized system, evaluated at the nontrivial steady-state, is given by

$$J(\tilde{k}, \tilde{\tau}, \tilde{q}) = \begin{bmatrix} g_1 & g_2 & g_3 \\ g_1 \left(\frac{P}{R} \right) & \left(\frac{S}{R} \right) & g_3 \left(\frac{P}{R} \right) \\ 0 & 1 & 0 \end{bmatrix}. \quad (\text{A.140})$$

First, I find the matrix $(J - \eta I)$, where η represents an eigenvalue of J :

$$J - \eta I = \begin{bmatrix} g_1 - \eta & g_2 & g_3 \\ g_1 \left(\frac{P}{R} \right) & \left(\frac{S}{R} \right) - \eta & g_3 \left(\frac{P}{R} \right) \\ 0 & 1 & -\eta \end{bmatrix}. \quad (\text{A.141})$$

Obviously, the characteristic equation is given by $\text{Det}(J - \eta I) = 0$. After some steps, I am able to express the characteristic equation as

$$\eta \left\{ (g_1 - \eta) \left(\eta - \frac{S}{R} \right) + (g_1 g_2 + g_3) \left(\frac{P}{R} \right) \right\} = 0, \quad (\text{A.142})$$

and thus, one of the roots of this equation is $\eta = 0$. The remaining roots solve the quadratic equation

$$\eta^2 - \left[g_1 + \left(\frac{S}{R} \right) \right] \eta - \left[(g_1 g_2 + g_3) \left(\frac{P}{R} \right) - g_1 \left(\frac{S}{R} \right) \right] = 0. \quad (\text{A.143})$$

Equation (A.143) leads in a very straightforward way to equation (86) in Chapter I. Also, equations (87) and (88) in Chapter I follow in a very straightforward but algebraically intensive way from equations (82), (83), (84) and (85) in Chapter I.

Appendix B

Technical Appendix for Chapter II

1 Proof for Proposition 1

Proposition 1. *If, as assumed, $y_1 < y_2$, in the equilibrium with no financial integration (financial autarky), the resale price of the debt in the financial periphery ($q_{1,t+1}^a$) is lower than the one in the financial center ($q_{2,t+1}^a$).*

Proof: $q_{1,t+1}^a$ and $q_{2,t+1}^a$ are the resale price of the debt in Country 1 and Country 2, respectively, when both countries are in the financial autarky equilibrium. It is clear that

$$\text{i) } q_{1,t+1}^a = y_1 < 1 \quad (\text{B.1})$$

$$\text{ii) } q_{2,t+1}^a = \begin{cases} \frac{y_2}{(1-\lambda_{t+1})}, & \text{if } 0 < \frac{y_2}{(1-\lambda_{t+1})} < 1 \\ 1, & \text{if } \frac{y_2}{(1-\lambda_{t+1})} > 1 \end{cases} \quad (\text{B.2})$$

By assumption, $y_1 < 1$ and $y_1 < y_2$. We also know that $0 < (1-\lambda_{t+1}) < 1$. Hence

$$q_{1,t+1}^a < q_{2,t+1}^a, \forall t. \text{ Q.E.D.}$$

2 Proof for Proposition 2

Proposition 2. *In the liquidity-constrained world-integrated equilibrium, when there is a common outside currency, the following holds as a result of arbitrage in the resale market for debt: a) the financial center shares gold-reserves with the financial periphery,*

and b) the liquidity premium is such that $\left(\frac{1}{q_{2,t+1}^a}\right) < \left(\frac{1}{q_{t+1}}\right) < \left(\frac{1}{q_{1,t+1}^a}\right)$.

Proof: Part a) From Proposition 1, we know that $q_{1,t+1}^a < q_{2,t+1}^a$. Hence, in equilibrium, Country 1's old bankers do not have incentives to transfers reserves to Country 2's central island (i.e., $x_{1,t+1} = 0$). On the other hand, Proposition 1 also implies that, in equilibrium, Country 2's old bankers do take gold-reserves to Country 1's central island. By arbitrage, the resale price of the debt is equalized across countries, and $x_{2,t+1}$ will be such that $q_{1,t+1} = q_{2,t+1} = q_{t+1}$ or, equivalently,

$$\frac{(y_1 + x_{2,t+1}y_2)w_t}{w_t} = \frac{(1 - x_{2,t+1})y_2w_t}{(1 - \lambda_{t+1})w_t} \quad (\text{B.3})$$

Solving for $x_{2,t+1}$ and using Proposition 1, we get

$$0 < x_{2,t+1} = \left(\frac{1}{2 - \lambda_{t+1}}\right) - \left(\frac{y_1}{y_2}\right) \left(\frac{1 - \lambda_{t+1}}{2 - \lambda_{t+1}}\right) < 1 \quad (\text{B.4})$$

$x_{1,t+1} = 0$ and $0 < x_{2,t+1} < 1$ altogether imply that the financial center shares reserves with the periphery.

Part b) Using (B.3) and (B.4), it follows that, in equilibrium,

$$q_{t+1} = \left(\frac{y_1 + y_2}{2 - \lambda_{t+1}} \right) < 1 \quad (\text{B.5})$$

Combining (B.5) with Proposition 1, it becomes clear that $\left(\frac{1}{q_{2,t+1}^a} \right) < \left(\frac{1}{q_{t+1}} \right) < \left(\frac{1}{q_{1,t+1}^a} \right)$

Appendix C

Technical Appendix for Chapter III

Alternative Fiscal Policies

1 Alternative Policy 1: To Give Equal Lump-Sum Transfers to all Young Agents

If all agents receive the same lump-sum transfer of τ_t goods, independently of their type, the (binding) self-selection constraint becomes

$$rw(k_t) + [r - \pi f'(k_{t+1}) - (1 - \pi)x]\tau_t = \{\pi[f'(k_{t+1}) - \rho_t] + (1 - \pi)x\}b_t \quad (C.1)$$

A policy will be neutral in this environment if the policy does not affect the self-selection constraint or, equivalently, if the resulting transfer of goods does not appear in the self-selection constraint (C.1). In this particular case, the Alternative Policy 1 is neutral if and only if $[r - \pi f'(k_{t+1}) - (1 - \pi)x] = 0$ because only if this is the case, then any nontrivial value of τ_t does not appear in the self-selection constraint (C.1). However, there is a unique capital stock $\tilde{k}$ that ensures that $[r - \pi f'(\tilde{k}) - (1 - \pi)x] = 0$. It is easy to show that

$$\tilde{k} = \left[\frac{r - (1 - \pi)x}{\alpha\pi A} \right]^{\frac{1}{(\alpha-1)}}, \text{ constant} \quad (\text{C.2})$$

Therefore, $[r - \pi f'(k_{t+1}) - (1 - \pi)x] = 0$ only under very special circumstances, that is, only when, by coincidence, $k_{t+1} = \tilde{k}$. As a result, the Alternative Policy 1 is not neutral because it does affect the self-selection constraint.

2 Alternative Fiscal Policy 2: To Give Transfers Specific to Young Agents of Each Type so that the Policy is Neutral

Under this policy, young Type 1 agents receive τ_{1t} goods and young Type 2 agents receive τ_{2t} goods. τ_{1t} and τ_{2t} are set by the monetary authority so that the self-selection constraint is not affected. Under the Alternative Policy 2, the self-selection constraint becomes

$$rw(k_t) + \{r\tau_{1t} - [\pi f'(k_{t+1}) + (1 - \pi)x]\tau_{2t}\} = \{\pi[f'(k_{t+1}) - \rho_t] + (1 - \pi)x\}b_t \quad (\text{C.3})$$

The Alternative Policy 2 is defined so that is neutral, in the sense that the self-selection constraint is not affected. Therefore, for this policy to be neutral, it must be the case that

$$\tau_{1t} = \left\{ \frac{[\pi f'(k_{t+1}) + (1-\pi)x]}{r} \right\} \tau_{2t} \quad (C.4)$$

and (C.3) becomes

$$rw(k_t) = \{ \pi [f'(k_{t+1}) - \rho_t] + (1-\pi)x \} p_t \quad (C.5)$$

Thus, the Alternative Policy 2 is neutral because it does not affect the self-selection constraint.

However, from (C.3) it is possible to appreciate that the Alternative Policy 2 seems to be highly sophisticated. In addition to that, due to the presence of private information, it would be hard for the monetary authority to distinguish between young Type 1 agents and young Type 2 agents. Thus, the Alternative Policy 2 does not seem to be a credible policy when it comes to implementation.

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