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Currency Crises and the Real Economy: The Role of Banks

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Abstract

This paper shows that the *quality* of banks within each country is one of the important factors that can account for the fact that developing economies tend to suffer more severe output contractions in the wake of a currency crisis than more mature economies. In particular, countries with a banking sector whose balance sheets are healthy, in terms of having high net worth and low foreign currency exposure, are much less likely to suffer a contraction in the wake of an unexpected depreciation.

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Contents Page

I. Introduction 3

II. Empirical Motivation 4

III. The Model 5
A. Firms 6
B. Domestic Banks 7
C. Investors 9
D. Equilibrium Determination 10

IV. Analysis 12
A. Effects on the Costs of Funds 14

V. Discussion 15
A. Exuberance, Over-Lending, and Perceptions 16

VI. Conclusion 17

Figures
1. Macroeoconomic Developments 18
2. Banking Sector Developments 19
3. Asian Countries 1997-1998: Exchange Rates and Foreign Liabilities/Assets 20
4. ERM Countries 1992-1993: Exchange Rates and Foreign Liabilities/Assets 21
5. Firm's Optimal Level of Employment 22
6. The Conditional Probability of Default 22
7. Contractionary Depreciation 23
8. Bank's Expected Cost of Funds 23
9. Equilibrium Employment and Net Worth 24
10. Restriction on c 24

Appendix I 25
A. Investor's Zero Profit Condition 25
B. Restriction on c 25
C. Proof that $\underline{w} < \overline{w}$ 26

References 27

I. INTRODUCTION

Recent 'second generation' models of currency crises are predicated on the assumption that there exists a trade-off between defending a peg and devaluing. In particular, the presence of nominal rigidities implies that a devaluation will be expansionary, while a defense comes at the cost of high interest rates, so that the policy dilemma is cast in terms of a devaluation versus a recession. However, a notable feature of recent experiences of currency crises has been the fact that for countries that succumbed to a devaluation, the aftermath on the real economy has been strikingly different for developed and developing economies. The former have tended to fare a lot better whereas complete output collapse is often experienced by the latter.[2] This raises some important issues which the extensive literature on currency crises has yet to resolve. Specifically, what are the macroeconomic impacts of currency crises, and why have they differed so much between episodes? And in particular, why has the experience been so different for developing and developed countries?

The current study contends that the *health* of the banking system may constitute a large part of the answer to the questions posed above, and presents a very simple and intuitive model to illustrate the arguments. The focus is on the way in which banks' unhedged foreign currency liabilities compromised their balance sheets and led to contractions in the real economy. This was particularly relevant in the Asian countries because a depreciation meant that banks and financial institutions were suddenly faced with drastic deteriorations in their net worth and subject to a loss of confidence from their creditors. The financial distress of banks meant that it was almost impossible for local exporters to get the credit they needed to take advantage of their increased international competitiveness. Thus the benefits to exporters proved elusive and the devaluation turned out to be painful.

This paper departs from previous studies by explicitly modelling the banking sector and formally taking into consideration the role of bank balance sheets. As such, it is possible to discuss how differences in the *quality* and *health* of the banking system determine the real effects of a depreciation. Following in the conceptual foot steps of Bernanke and Blinder (1988, 1992), the model focuses on the 'bank lending channel' which assumes that many firms in the economy are critically dependent on bank credit for their operations. The model allows for the possibility that financial intermediaries may hold speculative open positions in foreign exchange. Such positions are shown to increase the vulnerability of the financial system to currency crisis and possibly mitigate any expansionary effects of a devaluation. Specifically, when the banking sector is healthy, the standard Keynesian effect applies - output increases as monetary policy is eased and real factors costs decline, but when banks are weak, a devaluation will bring about contractions in the real economy. An economy whose banks are weak, in terms of low net worth, high exposure to currency risk, and bad quality assets, is much more vulnerable to output collapse in the wake of a currency crisis.

[2]In the ERM crisis, the countries which were driven off their pegs generally did better in the following period than those that stuck with their currencies. In the Latin American and Asian crises, however, the decision to devalue have led to severe short-run consequences for the real economy.

Chang and Velasco (1998) analyzed the interaction between financial intermediaries and currency crisis in a model that builds on the 'bank run' framework of Diamond and Dybvig (1983). A crisis occurs when there is a self-fulfilling depositor panic which results in the collapse of the whole banking sector as well as the liquidation of real investments. An alternative attempt to incorporate banks into the currency crisis story has focussed on the idea of moral-hazard-driven lending. The intuition, first originated by Krugman (1998) and formalized by Corsetti, Pesenti, and Roubini (1998), is simply that the presumption of implicit government bail-out guarantees led banks to engage in a lending-craze which resulted in bad quality loans and huge losses for the banking sector as a whole. These losses meant that the government guarantee could not be maintained forever and foreign lenders eventually withdrew their funds.

While these models do capture some elements of the Asian crisis, none of them seem to really get at the essential nature of how banks drove the output collapse. The moral hazard story rationalizes the fall in output as the result of bad lending prior to the crisis and cites as evidence the large amount of non-performing loans that now beset the banking sector. However, as documented in the World Bank report *The Road to Recovery* (1998), the bulk of the bad loan problem is a *consequence* of the recessions and currency depreciations that were associated with the crises. The prevalence of non-performing loans ex-post certainly does not imply that a comparable amount of bad lending was taking place ex-ante. With respect to the Diamond-Dybvig type models, the implication is that the crisis should be characterized by pervasive bank runs and that the output cost can be associated mainly with the destruction of physical capital that results from early liquidation of investment projects. But the main channel through which the crisis has generated output loss is not so much the physical liquidation of unfinished projects but rather through the onset of severe recessions. In addition, there is scant evidence to suggest that a run on deposits was the main culprit in deepening the banking crisis.[3] The heart of the problem has more to do with the interaction between banking sector health, large currency depreciations, and macroeconomic performance that is the focus of the present study.

The rest of the paper is organized as follows. Section 2 examines some empirical motivation behind the model which is set out in Section 3. Section 4 analyzes the effects of a depreciation and shows how this is sensitive to the health of the banking system. Section 5 discusses some of the model's key implications. Section 6 concludes and some technical details are collected in an appendix.

II. Empirical Motivation

Before proceeding to the model, it is instructive to contrast the experiences of the 1997 Asian crisis with that of the 1992-93 ERM crisis.[4] Figure 1 shows nominal exchange rates and real output growth of the Asian and ERM countries through the crisis years from which it is clear that the former have experienced much more adverse output response than the latter. In

[3]Indonesia was the only country that experienced a significant bank run.

[4]Since the focus is on the real effects of devaluations, only the experiences of those countries which left the ERM are examined. These include the UK, Italy, Spain, Finland, Portugal, and Sweden

Finland and the UK, for example, output growth actually improved throughout the crisis years. These contrasting experiences are, to a large extent, a reflection of differences in the health of the banking system in these countries. Figure 2 shows the evolution of the ratio of non-performing loans to gross loans and return on average equity of commercial banks for the countries in the sample. The differences are striking: the Asian crisis was associated with a banking crisis while the ERM crisis was not. For the Asian countries, the devaluation was accompanied by an explosion of non-performing loans and dramatic declines in bank profitability. On the other hand, banks in the ERM countries made it through the crisis relatively unscathed. The difficulties faced by banks in Asia during the crisis stems in large part from the high exposure to exchange rate risk that dented their balance sheets considerably following the depreciations.[5] This is reflected in Figure 3 which shows how the depreciations magnified foreign liabilities relative to total assets, both measured in the domestic currency, of the banking system in the Asian countries. From Figure 4, it is apparent that the balance sheets of banks in the ERM countries were generally much less exposed to a depreciation.

These observations highlight the importance of bank balance sheets in influencing the real effects of a devaluation. It suggests that those countries—even among the Asian countries such as Singapore—that had a healthier banking sector tended to experience less severe output response. Finally, it is worth noting that while banking problems are harmful in both emerging and mature economies, they are potentially more disruptive in emerging markets because banks play a much larger role in developing countries. Firms in developing countries generally face difficulties in raising funds through the equity or commercial paper market, and bank credit therefore becomes the primary source of funds.[6] In addition, banks in developed countries are more well placed to recapitalize in the face of balance sheet deteriorations because their access to world capital markets are less limited. In contrast, financial institutions in Bangkok or Jakarta were lucky to find willing lenders when things started to go bad.

III. The Model

Consider a small open economy that produces a single tradable good using labor as the only input. The domestic price of the good, P, is given by the law of one price, $P = eP^*$, where e is the nominal exchange rate (price of foreign currency in terms of domestic currency) and P^* the foreign currency price of the good. The latter will be normalized to one in the ensuing analysis so that the domestic price of the good simply equals the exchange rate, $P = e$.

[5]Most of these external liabilities were not hedged because exchange rates were, in many cases, rigidly pegged to the US dollar with either limited variation or very predictable change. Thus investors perceived little risk in such obligations. Ironically, the Asian pegs seem to have enjoyed too much credibility prior to the crisis.

[6]The barrier against equity financing in developing countries are due primarily to informational asymmetries and the associated problems of adverse selection and moral hazard. See Mishkin (1996) for a discussion.

The model has three types of agents: firms, intermediaries, and foreign investors. All agents are risk-neutral and subject to limited liability so that negative payoffs are not possible. Since the focus of the paper is on what happens to output *after* a devaluation has occurred, it is assumed that e is realized at the beginning of the period. Having observed this, financial contracts are signed and production decisions made. At the end of the period output is sold, shocks are realized, and all claims are settled.

A. Firms

Firms are ex-ante identical and must obtain credit to finance their working capital prior to production and sale of output. They are not able to borrow directly from the capital market and must therefore rely on domestic banks for funds. All firms have access to the same technology and are subject to a random productivity shock that is independently distributed across firms. In particular, output of firm i is governed by

$$y_i = M_i^{\beta}\left(1 + \varepsilon_i\right), \qquad 0 < \beta < 1$$

where M_i represents units of labor employed and ε_i is the idiosyncratic productivity shock faced by firm i. This shock is assumed to be binomially distributed such that

$$\varepsilon_i = \begin{cases} \overline{E} & \text{with probabiliy} \quad \theta \\ \underline{E} & \text{with probabiliy} \quad (1-\theta)\,. \end{cases}$$

To simplify the exposition, it will be assumed that $\overline{E} = 0$ and $\underline{E} = -1$ so that output equals zero with probability $(1-\theta)$ in which case the firm has no choice but to default. This can be thought of as the state of bankruptcy. In the event of default, banks seize the realized value of firms' output.

Since firms are ex-ante identical, the focus will be on the representative firm and the subscript i will be omitted in what follows. Denoting the cost of labor by P_M and the contractual interest rate between firms and domestic banks by r_L, the expected profits of the firm is given as

$$\Pi^e = \theta\left(eM^{\beta} - \left(1 + r_L\right) P_m M\right). \tag{1}$$

Note that the existence of limited liability implies that firms only repay their debt if the productivity shock turns out to be favorable.

In line with second-generation models of currency crisis, some kind of nominal rigidity must be imposed in order for there to be a perceived benefit to devaluing. One possibility is that the economy suffers from unemployment due to a downwardly rigid nominal wage rate and would benefit from a more expansionary monetary policy, which can not happen so long as the exchange rate is fixed.[7] Thus P_m will be taken as fixed in what follows.

Labor is assumed to be supplied elastically and firms choose how much to employ in order to maximize expected profits, taking r_L as given. The first order condition of this simple problem

[7] It is often argued that Britain's departure from the ERM in 1992 was motivated by such a trade-off.

implies that optimal employment is given as

$$M^* = \left[\frac{e\beta}{(1+r_L)\,P_m}\right]^{\frac{1}{1-\beta}}. \tag{2}$$

Since firms operate only when expected profits is non-negative, (1) implies that they can always repay their loans if the shock turns out to be favorable.

B. Domestic Banks

Domestic banks are risk neutral, competitive, and each lend to only one firm so that they are exposed to the idiosyncratic risk of firms. One can think of each firm being randomly matched with a single bank, from which it must obtain all of its desired borrowings. Banks use no resources in the process of intermediation and earn no expected profits in equilibrium. Because their assets are assumed to be illiquid, they must finance their loans completely by borrowing from foreign investors. The main function of these domestic banks is to intermediate between firms and investors, implicitly pledging their own capital as collateral for the loans. In the process, they absorb much of the idiosyncratic firm risk. Exactly how much risk domestic banks are able to absorb depends on the size of their capital relative to the desired borrowing by firms. In the event of default, the bank gets liquidated and its net worth transferred to investors.

The balance sheet of a representative bank is captured simply by

$$w = A - N_d - eN_f, \tag{3}$$

where A denotes assets and N_d stands for liabilities, all denominated in the domestic currency. N_f represents foreign currency denominated liabilities of the representative bank so that eN_f is the initial domestic currency value of foreign liabilities. Thus w is the net worth of a representative bank in terms of domestic currency at the start of the period.[8] Domestic banks are assumed to be identical ex-ante with a common value of w. However, they may be different ex-post because some firms will fail and those banks who lent to them will not be repaid. It is further assumed that banks' net worth are subject to a random disturbance during the period. This will be captured by the variable u, which is uniformly distributed over $[\underline{u}, \overline{u}]$ with $-1 < \underline{u} < 0 < \overline{u}$. Thus the net worth of a representative bank at the end of the period before any claims are settled will be[9]

$$\psi \equiv w(1+u).$$

The health of the financial sector is captured by the strength of banks' balance sheets interpreted broadly to also include their ability to withstand external shocks. Domestic banks are considered 'strong' if i) net worth(w) is high and/or ii) exposure to exchange rate risk is low (N_f small).

[8]For simplicity it is assumed that banks' assets are all denominated in the local currency. Relaxing this assumption makes no difference as long as foreign liabilities outweigh foreign assets so that a depreciation still reduces net worth.

[9]Here, the shock is taken to affect the overall net worth of banks. Alternatively, it could have been assumed that the shock affected only specific components of net worth, but at the cost of a less clean exposition. In any case, the underlying results and intuition are exactly the same.

In the case where a firm defaults, the bank that lent to it will be able to repay its creditors only if $\psi > (1+R)\,L$, where R is the interest rate at which it borrowed from investors and $L = P_m M^*$ is the size of the loan made to firms. This defines the critical value of shock to net worth

$$u^* = \frac{(1+R)\,L}{w} - 1, \tag{4}$$

such that a domestic bank whose loan goes bad(firm fails) will still be able to repay its creditors provided that $u > u^*$. It is thus possible to calculate the probability that a representative domestic bank will default, given that the firm to which it lent to failed, as

$$\begin{aligned} q &= \Pr(\psi < (1+R)\,L) \qquad (5)\\ &= \Pr(u < u^*) \\ &= \frac{u^* - \underline{u}}{\overline{u} - \underline{u}} \end{aligned}$$

This will be referred to as the *conditional default probability* of domestic banks.

The next step is to calculate the unconditional probability that a domestic bank will default. Since a domestic bank will default if and only if the firm that it lent to failed *and* its net worth turns out to be insufficient to cover its debts, this probability can be characterized by

$$1 - x = (1-\theta)\,q,$$

where x is the probability that domestic banks will repay fully. Note that

$$x = \begin{cases} \theta & \text{if } \; q = 1 \\ 1 & \text{if } \; q = 0. \end{cases}$$

Given that domestic banks can obtain funds from investors at the contractual rate of R, their expected cost of funds, R^e, will be determined by[10]

$$(1+R^e)\,L = x\,(1+R)\,L + (1-x)\,\psi^e. \tag{6}$$

where ψ^e is the expected net worth of a domestic bank which defaults. It represents how much each bank expects to lose when it is unable repay investors. Formally,

$$\begin{aligned} \psi^e &= E\,[\psi | \psi < (1+R)\,L] \\ &= w\left[1 + \frac{\int_{\underline{u}}^{u^*} u g(u)\,du}{G(u^*)}\right], \end{aligned}$$

where $g(u)$ and $G(u)$ represent the pdf and cdf of u respectively. Finally, the contractual interest

[10]Note that the expected cost of funds takes into consideration the case where foreign investors are repaid out of domestic bank's net worth. The expected cost of this outcome is $(1-\theta)(1-q)(1+R)\,L$.

rate between domestic banks and firms will be given by

$$(1 + r_L) = \frac{(1 + R^e)}{\theta}. \tag{7}$$

C. Investors

Investors are risk-neutral and provide funds to domestic banks in a competitive market. Their cost of funds, in terms of domestic currency, is assumed to be given exogenously by $(1 + r^*)$. Since domestic banks are ex-ante identical, the contract offered to each bank will be identical. Specifically, the contractual interest rate, R, will be determined by

$$(1 + r^*)L = x\,(1 + R)\,L + (1 - x)\,(\psi^e - c)\,, \tag{8}$$

where c represents the contract enforcement costs in the event of a default. It captures the costs associated with bankruptcy proceedings to claim the net worth of the defaulting party.[11]

Appendix I.A shows that the contractual interest rate can be represented as a mark-up rule where it exceeds investors' cost of funds by the sum of two terms: the first is the expected revenue lost in the case of default, and the second captures the expected costs of contract enforcement. That is,

$$R - r^* = \frac{(1 - \theta)}{L}\left[\int_{\underline{u}}^{u^*} [w\,(u^* - u)]\,g\,(u)\,du + c\int_{\underline{u}}^{u^*} g\,(u)\,du\right].$$

The zero-profit condition for investors, (8), can be combined with (4), (5), and rearranged as[12]

$$H \equiv \frac{w\,(1 - \theta)\,(\overline{u} - \underline{u})}{2}q^2 + [(1 - \theta)\,c - (\overline{u} - \underline{u})\,w]\,q - w\,(1 + \underline{u}) + (1 + r^*)\,P_m M = 0, \tag{9}$$

which gives q as a function of M. Since q is a probability, it will be restricted to lie between 0 and 1. Although there will in general be two solutions for q in terms of M, assuming that the cost of bankruptcy proceedings is small enough such that

$$\frac{w\,(\overline{u} - \underline{u})\,\theta}{(1 - \theta)} > c \tag{10}$$

guarantees that (9) yields a unique correspondence between q and M for $q \in (0, 1)$. Also from (9), it follows that

$$q = 0 \quad \text{for} \quad M = \frac{w\,(1 + \underline{u})}{P_m\,(1 + r^*)} \equiv M_L \tag{11}$$

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[11]Implicit in (8) is the assumption that the expected rate of depreciation is zero, otherwise there would an additional term to reflect compensation for this risk. This simplifying assumption is made since the focus is on what happens *after* a devaluation rather than what causes one.

[12]See appendix I.A for details.

and

$$q=1 \quad \text{for} \quad M=\frac{w\left(1+\underline{u}\right)+w\left(\overline{u}-\underline{u}\right)-\left(1-\theta\right)c-\frac{w(1-\theta)(\overline{u}-\underline{u})}{2}}{P_m\left(1+r^*\right)} \equiv M_H. \tag{12}$$

It can be shown that (10) implies that $M_H > M_L$ and the existence of a positive relationship between M and q. Intuitively as M increases, the size of the desired loan gets larger and hence it becomes more likely that a domestic bank will not have enough net worth to payback its creditors if the firm defaults. The conditional probability of default can be characterized generally by

$$q=\begin{cases} 0 \quad \text{for} \quad M \leq M_L \\ 1 \quad \text{for} \quad M \geq M_H \\ \{\min(q): H=0\} \quad \text{for} \quad M_L < M < M_H. \end{cases} \tag{13}$$

Finally, combining (6) with (8) yields the expected cost of funds for domestic banks as

$$\left(1+R^e\right)=\left(1+r^*\right)+\left(1-x\right)\frac{c}{L}, \tag{14}$$

which can then be used in conjunction with (2) and (7) to give

$$G \equiv \left(1+r^*\right)P_m M+\left(1-x\right)c-\theta e\beta M^\beta=0. \tag{15}$$

This yields another relationship between M and q which must hold in equilibrium.

D. Equilibrium Determination

Equations (9) , (13) , and (15) solve the model. Basically, (15) determines how the level of employment that firms choose is affected by q, while (9) and (13) give the equilibrium value of q implied by each level of employment. The system is characterized by

$$\begin{aligned} \frac{\partial G}{\partial M} &= \left(1+r^*\right)P_m-\theta e\beta^2 M^{\beta-1}>0 \text{ (in equilibrium)} \\ \frac{\partial^2 G}{\partial M^2} &= -\theta e\left(\beta-1\right)\beta^2 M^{\beta-2}<0 \\ \frac{\partial G}{\partial q} &= \left(1-\theta\right)c>0; \qquad \frac{\partial^2 G}{\partial q^2}=0, \end{aligned} \tag{16}$$

and

$$\begin{aligned} \frac{\partial H}{\partial q} &= \left(1-\theta\right)c-w\left(\overline{u}-\underline{u}\right)x<0; \quad \frac{\partial^2 H}{\partial q^2}=w\left(1-\theta\right)\left(\overline{u}-\underline{u}\right)>0 \\ \frac{\partial H}{\partial M} &= \left(1+r^*\right)P_m>0; \qquad \frac{\partial^2 H}{\partial M^2}=0. \end{aligned} \tag{17}$$

Figure 5 captures the $G=0$ locus which reflects how the optimum level of employment (M) is related to the conditional default probability of a domestic bank (q). It is the graphical representation of (15) and (16) . Define $M_{\min}$ to be the level of employment associated with

$\frac{\partial G}{\partial M} = 0$. This will be given as

$$M_{\min} \equiv \left[\frac{\theta e \beta^2}{(1+r^*) P_m}\right]^{\frac{1}{1-\beta}}.$$

Note that to guarantee the existence of an optimum M for all $q \in [0,1]$, one needs to assume that c is small enough such that the following holds[13]

$$c \leq \overline{c}, \tag{18}$$

where

$$\overline{c} = \frac{M_{\min} P_m (1+r^*) \left(\frac{1}{\beta} - 1\right)}{(1-\theta)}.$$

In general, there will be two values of M which is consistent with (15) for each $q \in (0,1)$. However, it can be shown that in equilibrium, firms will always prefer the higher value because this will yield them higher expected profits. When $q = 0$, the optimum level of employment will therefore be

$$\overline{M} \equiv \left[\frac{\theta e \beta}{(1+r^*) P_m}\right]^{\frac{1}{1-\beta}}. \tag{19}$$

This can be thought of as the first best level of employment because banks are essentially able to borrow at the risk-free rate and firms' cost of funds will be at their lowest. In this case, investors are guaranteed repayment even if the firm defaults on its obligation to the domestic bank. On the other hand, when $q = 1$, the preferred level of employment will be given by $\underline{M}$, the higher of the two values of M which satisfies (15) at $q = 1$. That is,

$$\underline{M} \equiv \max\left[M : (1+r^*) P_m M + (1-x) c - \theta e \beta M^\beta = 0\right]. \tag{20}$$

Thus the relevant portion of the $G = 0$ curve will be between $\overline{M}$ and $\underline{M}$ which is shown as the dashed curve in Figure 5. It can be verified that over this range, $\frac{\partial G}{\partial M} > 0$.

At the same time, (13) and (17) imply that equilibrium q will be related to M as depicted in Figure 6. The equilibrium of the system is then simply determined by the intersection of the two curves. Importantly, an equilibrium with $q \in (0,1)$ will obtain as long as the following conditions are satisfied

$$M_H > \underline{M} \quad \text{and} \quad M_L < \overline{M}. \tag{21}$$

As will be shown below, this implies a restriction on the initial net worth of domestic banks (w) to lie within a certain range. In particular, $M_H = \underline{M}$ implies that

$$w = \frac{(1+r^*) P_m \underline{M} + (1-\theta) c}{(1+\overline{u}) - \frac{(1-\theta)(\overline{u}-\underline{u})}{2}} \equiv \underline{w}, \tag{22}$$

[13] Appendix I.B shows how this restriction can be combined with restriction (10) to yield a unique condition on c.

while $M_L = \overline{M}$ yields

$$w = \frac{(1+r^*)\, P_m \overline{M}}{(1+\underline{u})} \equiv \overline{w}. \tag{23}$$

The fact that M_L and M_H are increasing in w implies that condition (21) is equivalent to restricting banks' net worth to satisfy[14]

$$\underline{w} < w < \overline{w}. \tag{24}$$

Hence if the net worth of banks lie within this range, the conditional probability of default will be between 0 and 1 in equilibrium.

IV. Analysis

Consider now the effects of an unanticipated devaluation of the domestic currency. Recall from (3) that

$$\frac{\partial w}{\partial e} = -N_f < 0.$$

Thus while the value of assets are unchanged, the debt burden of domestic banks are magnified by the depreciation and their net worth consequently declines. Suppose initially that $w \in (\underline{w}, \overline{w})$, so that equilibrium q lies strictly between 0 and 1 at the outset. The effects of a depreciation can then be characterized by

$$\begin{bmatrix} \frac{\partial G}{\partial M} & \frac{\partial G}{\partial q} \\ \frac{\partial H}{\partial M} & \frac{\partial H}{\partial q} \end{bmatrix} \begin{bmatrix} \frac{\partial M}{\partial e} \\ \frac{\partial q}{\partial e} \end{bmatrix} = \begin{bmatrix} \theta\beta M^{\beta} \\ -N_f \left[(1+\underline{u}) + q\,(\overline{u} - \underline{u}) \left(1 - \frac{(1-\theta)}{2} q\right)\right] \end{bmatrix}.$$

Applying Cramer's Rule, yields

$$\frac{\partial M}{\partial e} = \frac{\theta\beta M^{\beta} \frac{\partial H}{\partial q} + N_f \left[(1+\underline{u}) + q\,(\overline{u} - \underline{u}) \left(1 - \frac{(1-\theta)}{2} q\right)\right] \frac{\partial G}{\partial q}}{|J|}$$

and

$$\frac{\partial q}{\partial e} = \frac{-\frac{\partial G}{\partial M} N_f \left[(1+\underline{u}) + q\,(\overline{u} - \underline{u}) \left(1 - \frac{(1-\theta)}{2} q\right)\right] - \theta\beta M^{\beta} \frac{\partial H}{\partial M}}{|J|},$$

where $|J|$ is the Jacobian determinant. From (16) and (17) it is clear that $|J| < 0$ and

$$\frac{\partial M}{\partial e} \lesseqgtr 0 \quad \text{as} \quad \underbrace{\theta\beta M^{\beta} \frac{\partial H}{\partial q}}_{\substack{\text{Direct Production} \\ \text{Effect } (-)}} + \underbrace{N_f \left[(1+\underline{u}) + q\,(\overline{u} - \underline{u}) \left(1 - \frac{(1-\theta)}{2} q\right)\right] \frac{\partial G}{\partial q}}_{\substack{\text{Balance Sheet Effect} \\ (+)}} \gtreqless 0\,. \tag{25}$$

[14]See Appendix I.C for a proof that $\underline{w} < \overline{w}$.

The effects of a depreciation is therefore ambiguous and depends on the relative weights of two terms. The first is the direct production effect which tends to increase the equilibrium level of employment. This is due to the fact that given a fixed nominal wage rate, a depreciation will imply a decrease in real factor costs which encourages firms to hire more labor and expand output. The second term can be interpreted as the balance sheet effect which exerts a negative influence on the equilibrium level of employment. A depreciation will increase the foreign currency-denominated debt burden of domestic banks and lead to a fall in net worth. This implies that domestic banks cannot guarantee their funding of firms as effectively as before because the value of their collateral is lower. As shown below, this will lead to an increase in their expected cost of funds, which is then passed on to firms in the form of higher interest rates. The increase in cost of credit discourages firms from expanding their desired level of employment.

From (25), the larger the amount of foreign currency denominated liabilities (N_f) that a bank has, the larger is the balance sheet effect and the more likely it becomes that output will fall. On the other hand, if N_f was zero so that banks have no foreign currency exposure, then the balance sheet effect is zero and a depreciation will be expansionary as predicted by standard Keynesian models. The direct production effect can be expanded to yield

$$\theta\beta M^{\beta}\left[(1-\theta)\,c - w\,(\overline{u}-\underline{u})\,x\right],$$

which shows that higher net worth will make it more likely that this effect will dominate. Thus having a banking sector with a bigger capital base helps to mitigate the possibility of a contractionary depreciation. This also highlights the fact that both the *magnitude* of banks' net worth (w) as well as its *composition* (N_f) matter crucially in determining the real effects of a depreciation. A banking sector with low net worth does not necessarily imply that a depreciation will be contractionary if its exposure to foreign exchange risk is negligible. In general, however, countries whose banks have large net worth are less likely to suffer from contractionary depreciations.

Thus the existence of financial intermediaries alone does not imply that a currency crisis will reduce output. For this to occur, the *health* of the intermediaries have to be bad also. The *quality* of banks matter just as much as the fact that they perform the important role of channeling funds to credit-constrained firms. A banking sector with a healthy balance sheet, in terms of high net worth and little unhedged foreign debt, will be in a much better position to absorb the exchange rate losses associated with unexpected depreciations than one that lacks this equity cushion.[15]

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[15]It is also worth noting that currency crises are often associated with stock market declines which may hurt the assets of banks also. This is likely to compound the effects of increased debt burdens by reducing net worth even more with the consequence that any negative effects of the depreciation on the real economy will be magnified.

As for the effects of a depreciation on the conditional default probability of domestic banks, it can be verified that this is unambiguously positive,

$$\frac{\partial q}{\partial e} = \frac{-\theta\beta M^{\beta}\frac{\partial H}{\partial M} - \frac{\partial G}{\partial M}N_f\left[(1+\underline{u}) + q\left(\overline{u}-\underline{u}\right)\left(1-\frac{(1-\theta)}{2}q\right)\right]}{|J|} > 0.$$

Again, the expression can be decomposed into a direct production effect (first term in numerator) and a balance sheet effect (second term in numerator). The direct production effect of a depreciation is to increase the size of desired loans of firms while the balance sheet effect reduces the net worth of domestic banks, both of which make it more likely that they will not be able to repay investors the full amount in the case that firms default.

Figure 7 illustrates the effects on output of a depreciation for the case in which the balance sheet effect dominates the direct production effect. The initial equilibrium is at A with employment level M_0^* and conditional probability of default q_0. After the depreciation, the equilibrium moves to point B with lower employment, M_1^*, and a higher likelihood of domestic banks having insufficient funds to repay all of its debt at the end of the period, q_1.

A. Effects on the Costs of Funds

From (14) it follows that

$$\frac{\partial\left(1+R^e\right)}{\partial e} = \frac{(1-\theta)\,c}{P_m M}\left[\frac{\partial q}{\partial e} - \frac{q}{M}\frac{\partial M}{\partial e}\right],$$

which will be positive in the case where a depreciation is indeed contractionary. Intuitively, a higher q means that investors' likelihood of getting repaid in full is smaller so they require a higher R to compensate them for holding more risk. In addition, since investors bear the cost of contract enforcement, a lower M means that in the case of default, this expected cost *per unit of loan*, $(1-x)\,\frac{c}{L}$, is higher and investors will demand extra compensation for this also.[16] Hence, both effects will lead to a higher contractual rate of interest charged by foreign banks which directly increases domestic banks' expected cost of funds and hence firms' cost of credit.

Recall from above that the credit channel is present only if net worth is such that (24) is satisfied. Figure 8 illustrates how the domestic banks' expected cost of funds is related to net worth. If $w \notin (\underline{w}, \overline{w})$ then there is no balance sheet effect on output because the conditional probability of default(q) is unchanged. A depreciation still lowers net worth but the decline in net worth by itself will not affect R^e, and a depreciation will always be expansionary. In this case,

$$\frac{\partial\left(1+R^e\right)}{\partial e} = -\frac{(1-\theta)\,cq}{P_m M^2}\frac{\partial M}{\partial e} < 0$$

[16]There is actually one other effect, the expected payment in the case of a default *per unit of loan*, $(1-x)\,\frac{\psi^e}{L}$, will be higher which tends to reduce the rate of return required by investors. At the same time, domestic banks will face a higher expected cost of default *per unit of loan*, $(1-x)\,\frac{\psi^e}{L}$. Under risk neutrality, these two effects cancels out.

because absent any balance sheet effects, a depreciation will increase the optimum level of employment which implies lower cost of contract enforcement per unit of loan, and hence lower expected cost of funds in equilibrium.

V. Discussion

To isolate the balance sheet effect, Figure 9 illustrates how equilibrium employment changes as banks' net worth varies, holding the exchange rate fixed. In particular, countries with $w < \underline{w}$ or $w > \overline{w}$ don't experience balance sheet effects. Net worth affects optimum employment only when $w \in (\underline{w}, \overline{w})$ because over this range, the degree of risk absorption varies with net worth. If banks' net worth is low enough, investors know that they will not be repaid in full if the firms to which banks lent failed. In this case, domestic banks simply act as a channel for firms to obtain funds from investors but they do not affect the expected default probability that investors face. Investors therefore lend at an interest rate which takes into account the fact that they are completely exposed to firm risk. Firms' cost of funds in this case would be

$$(1 + r_L) = \frac{1}{\theta}\left[(1 + r^*) + \frac{(1-\theta)\,c}{P_m\underline{M}}\right].$$

There will be no balance sheet effect on output following a currency crisis because investors are already expecting the worst and this has been incorporated into the required rate of return.

On the other hand, countries whose banks are well capitalized and have strong net worth, enjoy cheaper access to foreign funds. Simply through the sheer size of its capital base relative to liabilities, domestic banks are able to completely absorb firms' risks and transform a risky asset into a risk-free one, which is then sold to investors. Here banks improve overall economic performance because they allow firms to borrow at the most favorable risk-discounted interest rate

$$(1 + r_L) = \frac{(1 + r^*)}{\theta}.$$

This is as if firms could borrow directly from investors.[17] Again, there is no balance sheet effect on output following a devaluation because investors are completely insured no matter what happens and therefore demand only that they earn as much as their cost of funds.

For countries with banks that have net worth in the intermediate range, investors are not completely insured against firm failures and the balance sheet effect does play a role because marginal changes in net worth will affect the degree with which domestic banks absorb firm risk. Here, a depreciation will worsen the balance sheet of banks, reduce the degree of risk absorption, increase the risk to investors, result in higher cost of funds, and possibly mitigate the expansionary pressures stemming from the direct production effect.

[17] In this case, domestic banks' cost of funds is equal to $(1 + r^*)\,L$ regardless of whether firms default or not. It is as if domestic banks were lending out of their own funds at the opportunity cost of $(1 + r^*)\,L$.

To the extent that developing countries are more likely to be characterized by banks with low net worth, output will be below potential and increasing net worth will expand real production. There are limits to the benefit of increasing capital base, however, because once net worth is large enough to effectively act as full collateral for banks' debt, the cost of funds will be at their minimum and output will not expand any further. Note also that the marginal benefit, in terms of real output, of recapitalizing banks is greater for banks with low net worth. Thus countries whose banks have relatively low net worth are more likely to benefit from recapitalization efforts.

A. Exuberance, Over-Lending, and Perceptions

The analysis above basically captures the notion that investors are more willing to lend to well capitalized banks because the perceived probability of default is smaller. Another interpretation is that investors lend more readily to countries whose banks receive implicit or explicit bail-out guarantees. In situations where the government may not be willing to let banks fail and will step into repay their debts if banks themselves are unable to do so, the *effective* net worth could be quite large. Provided that investors believe that this is quite credible, they will demand a lower premium on their funds than they would have otherwise. In this way, the idea that implicit bail out guarantees contributed to the lending boom in Asia prior to the crisis can be captured in this model. As opposed to Corsetti, Pesenti and Roubini (1998), it is not the case here that over-lending is driven by moral hazard on the part of domestic banks, rather the presumption of implicit guarantees - either from the countries' governments or the IMF - among *international lenders* leads them to under-estimate the actual risks involved. Exuberant international creditors over-estimated the net worth of banks, so that funds were made available at too low a cost which encouraged banks and firms in Asia to borrow excessively.

In addition, a slight modification to the model allows it to capture the idea that countries can be caught in a vicious downward spiral. In particular, suppose now that only firms know what their probability of failure is, so that banks and investors make their decisions based on their *perceptions* of what this probability may be. Let this expected probability be denoted by $(1-\theta^e)$. The model is exactly the same as before with θ replaced by θ^e and can be used to heuristically analyze the effects of a loss of confidence by the market. It can be verified that an increase in the expected probability of firm bankruptcy will tend to raise the expected cost of funds to domestic banks and result in a lower equilibrium level of employment. This can loosely capture a kind of 'knock-on effect' where a depreciation results in output contraction this period leading market participants to revise downwards their beliefs concerning the repayment probability of firms which, in turn, brings about further declines in output in the following period. Thus adverse changes in market perception will compound the contractionary effects of currency crises. Indeed, many of the Asian countries seems to have been caught in such a downward spiral.

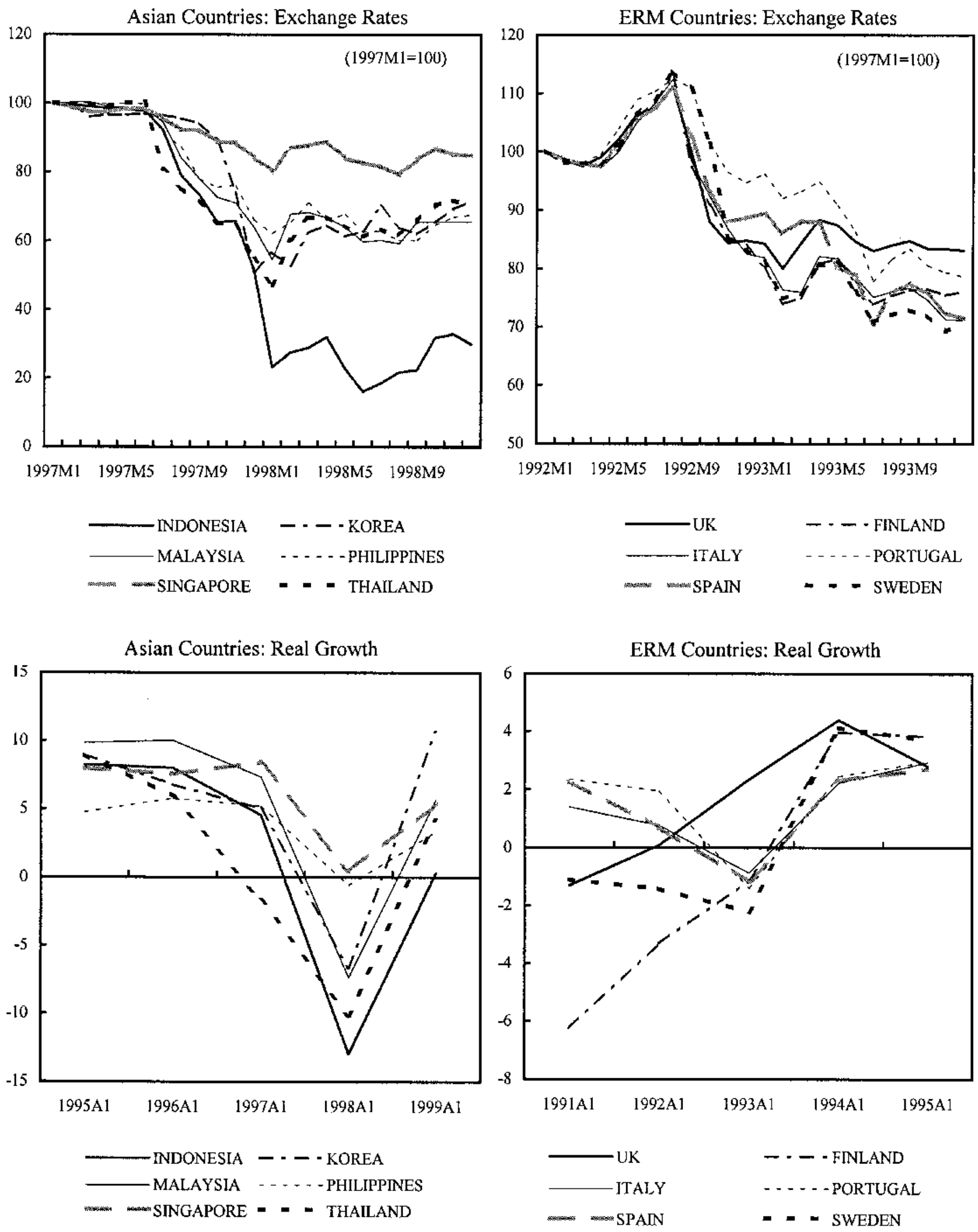
VI. Conclusion

Modern analysis of currency crisis emphasize the trade-off between high interest rates associated with a defense of a peg and the political costs of devaluing. It is implicitly assumed that a devaluation will be expansionary so that the policy dilemma is cast in terms of a devaluation versus a recession. This assumption, however, may not be valid in the presence of a weak banking sector. If domestic banks have large amounts of unhedged foreign currency debt, then a devaluation will further weaken their balance sheets and bring about a credit crunch. Rather than helping to improve the economic situation through monetary easing, a devaluation may exacerbate the fragility and vulnerability of the domestic financial sector. Indeed, there seems little doubt that in recent experiences of currency crises, the state of the banking sector has played an important role in influencing how the real economy is affected by the crisis. In particular, more mature economies with strong financial sectors have been much more successful in coping with these crises and avoiding the collapse in output that are often afflicted on developing economies.

This paper has attempted to rationalize these observations in a very simple yet formal setting. By explicitly considering the role of bank capital, it is possible to discuss how the *quality* and *health* of financial intermediaries determine the economy's response to a currency crisis. The analysis highlights two potential factors that may help to insulate the real economy from any adverse consequences of a depreciation. First, well capitalized banks are better placed to deal with such a shock because they can use their equity to cushion the rise in the debt burden. Secondly, a banking sector that is 'prudent', in the sense of not having large unhedged foreign currency denominated liabilities, will be more resilient to currency crises because their exposure to exchange rate movements is small.

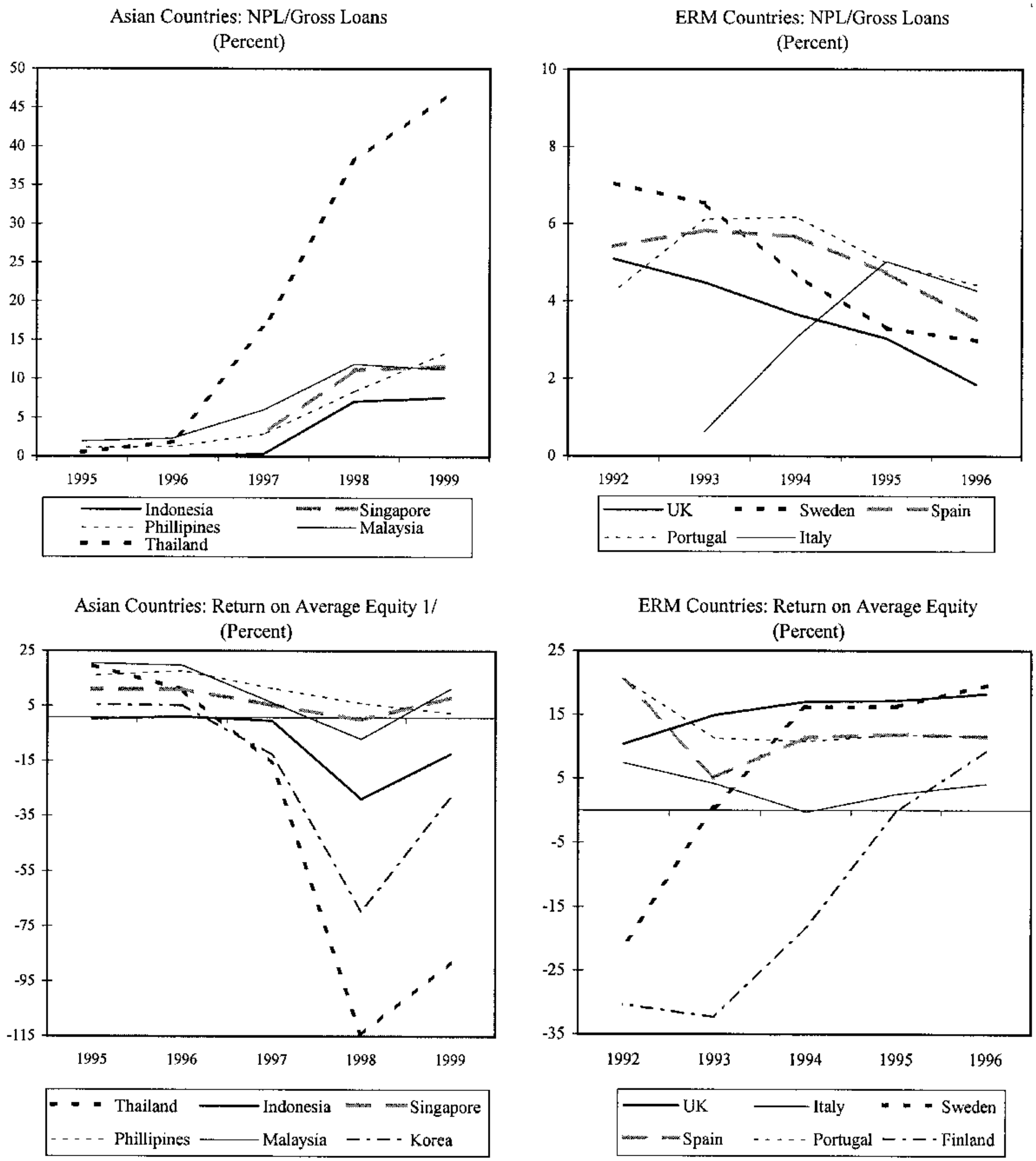
The observation that large output contractions can be the result of a sudden deterioration in banks' net worth suggests a possible response to the crisis. Specifically, quick steps to recapitalize banks and improve their balance sheets will allow them to intermediate funds more effectively as investors regain confidence in being repaid. However, the magnitude of the potential harm from unhedged short-term foreign borrowing highlights the need for preventative measures. The model stresses the importance of effective regulation and supervision of financial markets, limiting in particular the speculative currency positions of banks who form the core of the domestic payments system and may, therefore, become too complacent in believing that they enjoy a public guarantee. The model also provides some support for the role of central banks as lenders of last resort. In particular, it may be advisable to bail out banks, even those that made bad decisions in the face of large systemic shocks, if they are the only source of credit for domestic firms. The consequences of letting banks fail are likely to be detrimental to the real economy if they are the life-line for much of the production process.

Figure 1. Macroeconomic Developments



Source: IFS, WEO, Author's Calculations.

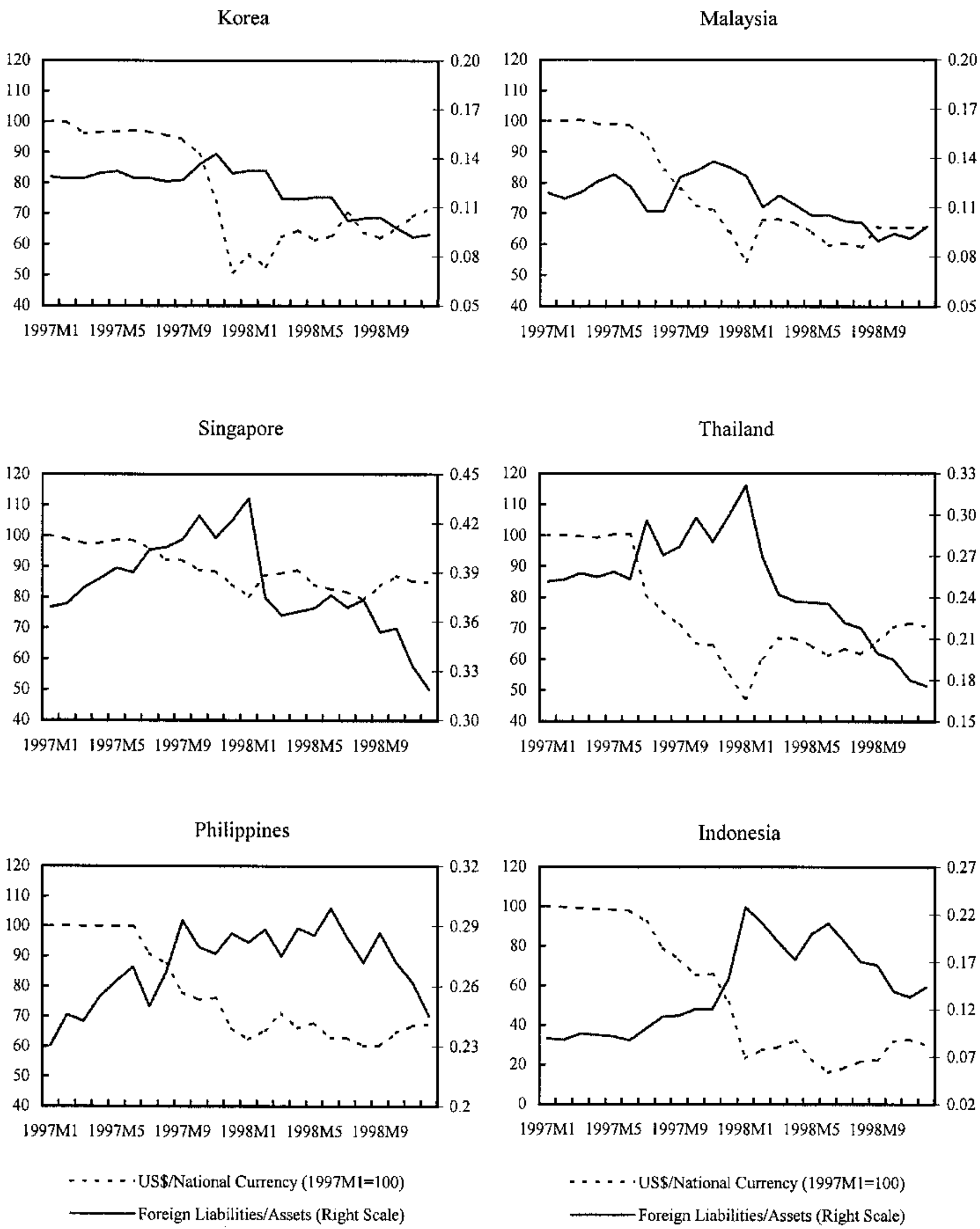
Figure 2. Banking Sector Developments



Source: BankScope Database, Author's Calculations.

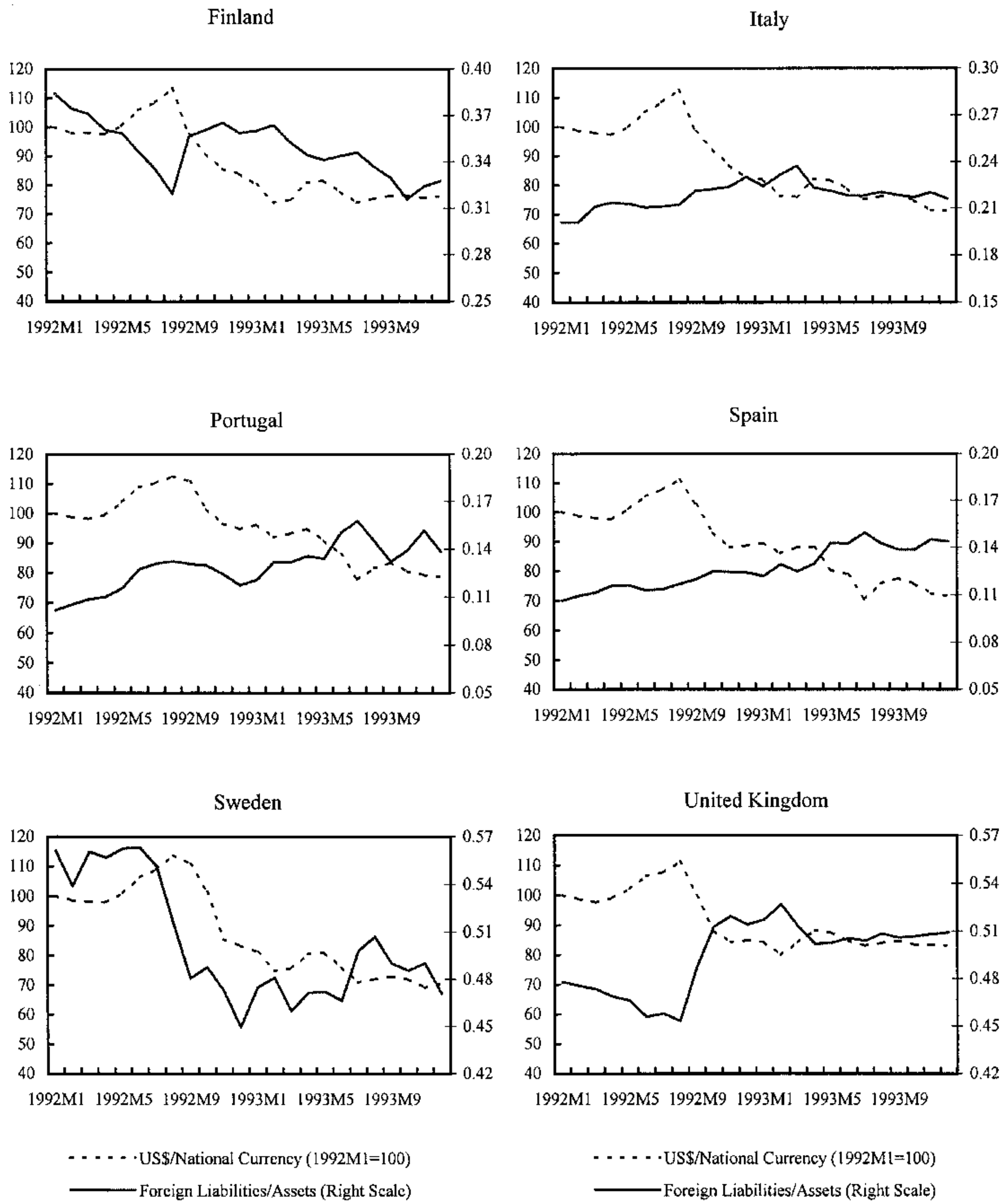
1/ The series shown for Indonesia is actually Return on Average Assets rather than Return on Average Equity since the latter was not available for Indonesia.

Figure 3. Asian Countries 1997-1998:
Exchange Rates and Foreign Liabilities/Total Assets



Source: IFS, Author's Calculations.

Figure 4. ERM Countries 1992-1993:
Exchange Rates and Foreign Liabilities/Total Assets



Source: IFS, Author's Calculations.

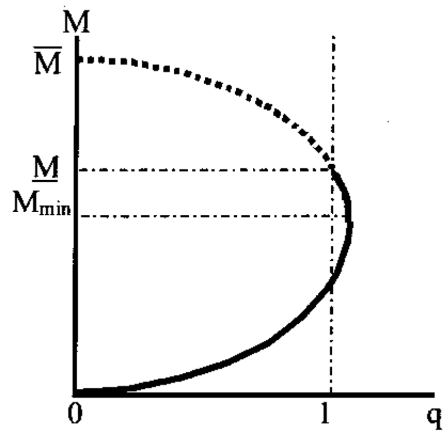


Figure 5. Firm's optimal level of employment.

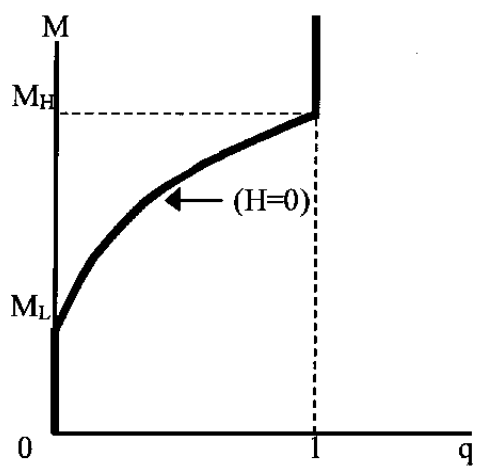


Figure 6. The conditional probability of default.

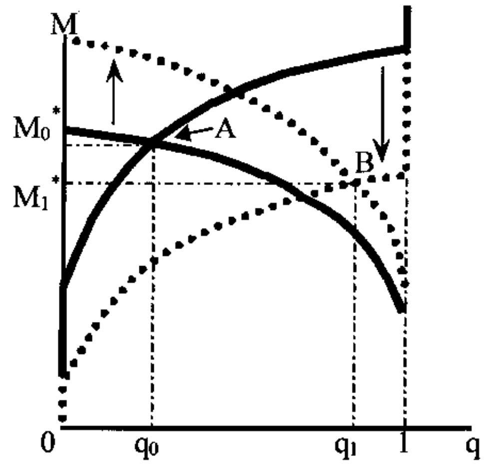


Figure 7. Contractionary depreciation.

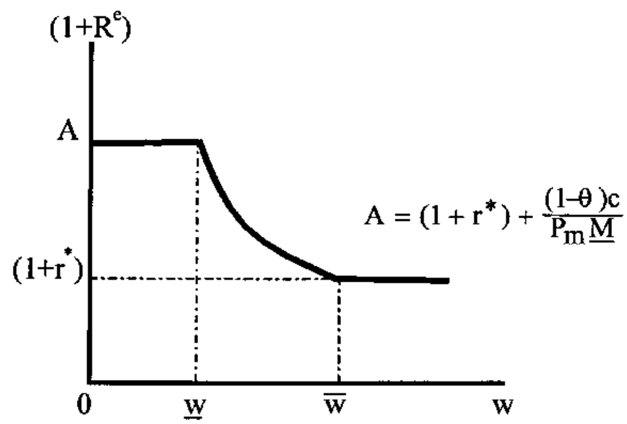


Figure 8. Banks' expected cost of funds.

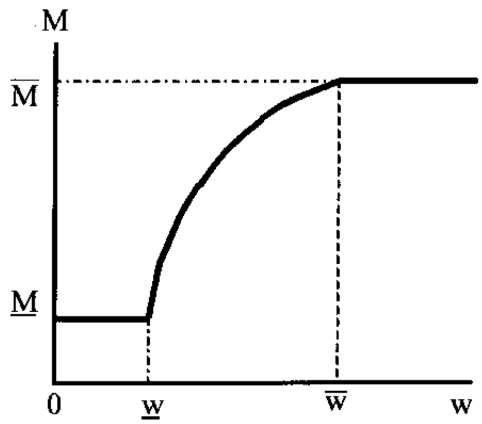


Figure 9. Equilibrium employment and net worth.

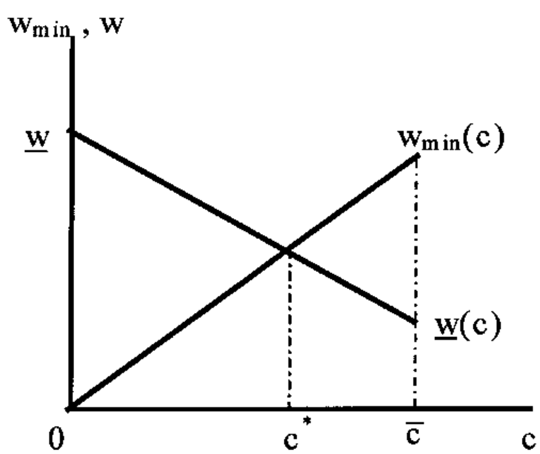


Figure 10. Restriction on *c*.

APPENDIX I

A. Investor's Zero-Profit Condition

Equation (8) can be written as

$$\begin{aligned}(1+r^*)\,L &= \left[\theta+(1-\theta)\int_{u^*}^{\overline{u}} g(u)\,du\right](1+R)\,L+(1-\theta)\int_{\underline{u}}^{u^*}[w\,(1+u)-c]\,g(u)\,du \\ &= (1+R)\,L+(1-\theta)\int_{\underline{u}}^{u^*}[w\,(1+u)-c-(1+R)\,L]\,g(u)\,du.\end{aligned}$$

Using (4), this can be written as

$$(1+r^*)\,L=(1+R)\,L+(1-\theta)\int_{\underline{u}}^{u^*}[w\,(u-u^*)-c]\,g(u)\,du.$$

Expanding the integral gives

$$(1+r^*)\,L=(1+R)\,L-(1-\theta)\left[\frac{c\,(u^*-\underline{u})}{\overline{u}-\underline{u}}+\frac{w\,(u^*-\underline{u})^2}{2\,(\overline{u}-\underline{u})}\right],$$

which simplifies to

$$(1+r^*)\,L=(1+R)\,L-(1-\theta)\,cq-\frac{w\,(1-\theta)\,(\overline{u}-\underline{u})}{2}q^2.$$

Finally, using (4) and (5) to substitute in for $(1+R)\,L$ yields (9) in the text.

B. Restriction on c

Recall from the text that the following assumptions were made: i) $c<\overline{c}$; ii) $w\,(\overline{u}-\underline{u})>(1-\theta)\,c$ for all $w\in(\underline{w},\overline{w})$. Since $\underline{w}$ is a decreasing function of c, the latter condition is equivalent to restricting c such that

$$\underline{w}>\frac{(1-\theta)\,c}{\theta\,(\overline{u}-\underline{u})}\equiv w_{\min}.$$

This is illustrated in Figure 10 which shows that the restriction will be satisfied if $c<c^*$. Specifically, c^* is determined by

$$\frac{(1+r^*)\,P_m\underline{M}^*+(1-\theta)\,c^*}{(1+\overline{u})-\frac{(1-\theta)(\overline{u}-\underline{u})}{2}}=\frac{(1-\theta)\,c^*}{\theta\,(\overline{u}-\underline{u})},$$

where $\underline{M}^*$ is the value of $\underline{M}$ evaluated at $c=c^*$,

$$\underline{M}^*=\max\left[M:(1+r^*)\,P_mM+(1-x)\,c^*-\theta e\beta M^{\beta}=0\right].$$

Therefore, both restrictions on c will be satisfied so long as $c<\min\left[c^*,\overline{c}\right]$.

C. Proof that $\underline{w} < \overline{w}$

From (20) it follows that

$$\frac{\partial \underline{M}}{\partial c} = -\frac{(1-\theta)}{\left[(1+r^*)\,P_m - \theta e \beta^2 \underline{M}^{\beta-1}\right]} < 0,$$

so that

$$\begin{aligned}\frac{\partial \underline{w}}{\partial c} &= (1+r^*)\,P_m \frac{\partial \underline{M}}{\partial c} + (1-\theta) \\ &= (1-\theta)\left[1 - \frac{(1+r^*)\,P_m}{\left[(1+r^*)\,P_m - \theta e \beta^2 \underline{M}^{\beta-1}\right]}\right] < 0.\end{aligned}$$

On the other hand, $\overline{w}$ and $\overline{M}$ are independent of c. Furthermore, suppose that $c = 0$, then $\underline{M} = \overline{M}$ and

$$\begin{aligned}\underline{w} &= \frac{(1+r^*)\,P_m \overline{M}}{(1+\underline{u}) + (\overline{u} - \underline{u})\left[1 - \frac{(1-\theta)}{2}\right]} \equiv \underline{w}^{\max} \\ &< \frac{(1+r^*)\,P_m \overline{M}}{(1+\underline{u})} = \overline{w}.\end{aligned}$$

Therefore, given that $\underline{w}$ is decreasing in c, $\underline{w} < \overline{w}$ for all permissible range of c.

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