

A NOTE ON THE CREDIBILITY OF BANK-RUN-PREVENTING DEVALUATION POLICIES¹

ENRIQUE KAWAMURA²

I. Introduction

This paper analyzes a special feature of the Chang and Velasco [4] model (denoted as CV hereon). In a small open economy version of the Diamond-Dybvig model [5] (see [6] for a survey), Chang and Velasco show that a flexible exchange rate regime eliminates the possibility of runs and achieves the socially efficient allocation. However this result hinges on the assumption that the Central Bank (or the policy-maker) commits itself to apply such a policy from the beginning. The inefficient equilibrium is eliminated because all agents know that the peso will depreciate in the event of a run, as this is the policy announced and applied from the initial period. The question that this paper addresses is whether this type of policy is credible, in the sense that the Central Bank has the proper incentives not to deviate from the original announcement when a run actually takes place.

This type of credibility issues is important to be considered in these models. Most of the recent discussion on financial fragility and exchange rates (the main focus of the CV framework) has been analyzed in the context of emerging markets. In these types of economies lack of commitment in policy behavior is a common feature. In particular, exchange rate policies are usually subject to arbitrary changes. Sudden devaluations or unexpected switches from fixed to floating regimes are not uncommon. Relating this issue to the CV paper, it is obvious that the flexible rate regime can also be interpreted as an exchange rate *threat*. This means that the Central Bank commits itself to devalue the local currency whenever the proportion of consumers withdrawing early is higher than the proportion of impatient consumers. Nevertheless, the monetary authority may not *want* to apply this threat ex-post. For example, whenever the long term assets are not *too illiquid*, then it may be that the Central Bank prefers to let the commercial banking system fall rather than to

¹ I thank very useful comments from two anonymous referees. I also acknowledge Guido Cozzi and Huberto Ennis, who inspired this paper. All remaining errors are mine.

² Universidad de San Andres, Departamento de Economía, Vito Dumas 284 (1644) Victoria, Buenos Aires, Argentina. E-mail: kawa@udesa.edu.ar

devalue to save it.

The present paper shows conditions under which the CV policy is credible. I define an ex-post objective function for the Central Bank, consisting of the weighted average of all agents's utilities in the interim period. I show that when the long run asset is sufficiently illiquid in the short run then the CV devaluation threat (or flexible exchange rate policy) is credible. This means that when the liquidation value of the long run investment is sufficiently close to zero, the Central Bank prefers to devalue the local currency rather than letting the banking system fall. The intuition is simple. Allowing for bank failures implies liquidating the long term asset. Due to its illiquidity, this course of events only favors a fraction of the consumers which is very close to the fraction of impatient consumers. By applying the devaluation policy the ex-post social utility is strictly greater, since it implies no liquidation of the long term asset. However, when the liquidation value is not too low, it may be that the Central Bank prefers to let commercial banks fail than devalue the local currency. I present two examples characterizing the lower bound for the liquidation value above which the threat is not credible.

Regarding this credibility problem, the next natural question is whether there exists an alternative devaluation threat that can credibly prevent runs. The answer is affirmative, provided that some informational and (minor) preference assumptions hold. The main difference between this threat and the one in CV is that in the policy proposed in the present paper some portion of the long run asset is liquidated when the policy is activated. It is shown that regardless of the illiquidity of the long term asset, the Central Bank always prefers to devalue in the way described below rather than to allow for banking failure. In other words, this type of flexible exchange rate policy can always be implemented without incentive problems, given the informational assumptions in CV.

Section 2 shows the basic Chang and Velasco model. Section 3 analyzes the credibility issue of the flexible exchange rate policy given by CV. Section 4 presents an alternative devaluation threat that satisfies the incentive constraint. Section 5 concludes.

II. The Chang and Velasco Model

The CV model constitutes an extension of the Diamond and Dybvig [5] model to a small open economy. The objective of the paper is to analyze the existence of bank runs under different exchange rate regimes. The main result is that, with flexible exchange rates, bank runs are eliminated. This section describes briefly the original model as well as the characterization of the optimal al-

location and its implementation.

There are three periods, labeled as $t = 0, 1, 2$. There is a single consumption good. Goods can be invested in a long term investment technology such that per each unit invested at date 0 the technology gives $R > 1$ units at date 2. However, if liquidated in period 1, this technology only gives $r < 1$ units at that date. They can also be invested every period in a short run world asset with zero net return. As in the original CV framework assume two currencies, a foreign (*dollar*) and a domestic one (*peso*). The world investment gives one dollar per unit of good invested at date 0. The price in dollars of the consumption good is exactly one.

Consumers are ex-ante identical and receive at date 0 a positive endowment of the consumption good $e > 0$. These agents are subject to idiosyncratic taste shocks at date 1. With probability λ a consumer becomes impatient and derives utility from consumption of the good at date 1. Impatient consumers have a utility function given by $g(x)$, where x is the amount of good consumed by the impatient agent. With probability $(1 - \lambda)$ the consumer is patient and derives utility from consumption of the good at date 2 and the real holdings of pesos. Her utility function is $g\left(\chi\left(\frac{M}{E_2}\right) + y\right)$. Here y is the amount of good consumed by the patient agent, M is the nominal holdings of pesos and E_2 the exchange rate in period 2. The function χ is assumed to be continuously differentiable at least twice and have a strictly positive satiation point, denoted as \bar{m} . Also assume $\chi(0) = 0$. The function g is also assumed to be continuously differentiable at least twice, strictly increasing and strictly concave, and satisfies Inada conditions. Thus, the ex-ante utility function is

$$\lambda g(x) + (1 - \lambda) g\left(\chi\left(\frac{M}{E_2}\right) + y\right) \quad (1)$$

It is also assumed that agents cannot borrow from abroad. Also the realization of types (the fact that each consumer becomes either patient or impatient) is private information.

The Optimal Allocation

Let b be the amount of goods stored and k be the amount invested in the long term investment technology. I derive the social optimum in the usual way. The objective of the social planner is to maximize the ex-ante utility of each consumer 1 subject to the following constraints

$$b + k \leq e \quad (2)$$

$$\lambda x \leq b \quad (3)$$

$$(1 - \lambda) y \leq Rk \quad (4)$$

$$x, y, M, k, b \geq 0 \quad (5)$$

where $E_2 = 1$. The first constraint denotes the investment decision at date 0. The second constraint specifies that the per-capita consumption by all impatient consumers is financed entirely by the liquid technology. The third inequality specifies that the total per-capita consumption is financed by the long term technology. The last set of constraint includes all the standard non-negativity conditions. Given the assumptions on the function g the following first-order conditions are necessary and sufficient.

$$g' \left(\frac{e - k}{\lambda} \right) = Rg' \left(\chi(M) + \frac{Rk}{1 - \lambda} \right) \quad (6)$$

$$g' \left(\chi(M) + \frac{Rk}{1 - \lambda} \right) \chi'(M) = 0 \quad (7)$$

and given that g is strictly increasing, this second equation implies that $M^* = \bar{m}$. Then

$$g'(x) = Rg'(\chi(\bar{m}) + y) \quad (8)$$

and since $R > 1$ then $g'(x) > g'(\chi(\bar{m}) + y)$. Then $x < \chi(\bar{m}) + y$. Then the optimal allocation is incentive compatible. On the other hand it must be true that $\chi'(\bar{m}) = 0$. Then consumers get the satiation level of pesos in the optimal allocation. I call $(\bar{x}, \bar{y}, \bar{m})$ the solution to this problem.

Implementation Through Flexible Exchange Rates

CV show that the optimal allocation can be implemented through a competitive banking system with a Central Bank that fixes the exchange rate to one and acts as a lender of last resort. The banking system works as follows. In period 0 all consumers deposit their endowment e in a commercial bank. Each bank offers a contract that specifies a withdrawal at date 1 and 2, depending on the claimed type by each consumer (recall that consumers are ex-post different, but commercial banks cannot identify each type individually). In period 1, each consumer learns his own type. At the beginning of this period, each commercial bank sells $b = \lambda x$ dollars (from the short run investment)

to the Central Bank at a one-to-one exchange rate. The Central Bank also lends $(1 - \lambda) \bar{m}$ pesos at zero net interest rate. Impatient customers withdraw x pesos from banks. They sell these pesos to the Central Bank at a one-to-one exchange rate to get x dollars. Patient consumers withdraw \bar{m} pesos to be used as an asset. At date 2, private banks sell $Rk = (1 - \lambda) y$ dollars at a one-to-one rate to the Central Bank. Then all patient consumers return the \bar{m} pesos to the commercial banks, which at the same time return these pesos to the Central Bank. These consumers get y pesos from the commercial banks, which are sold at the Central Bank at the exchange rate of one. This shows how this banking system can implement the optimal allocation.

However, if the exchange rate were kept fixed at 1, in this regime the same contract leads to a second, inefficient equilibrium that involves a currency crisis, provided that r is low enough. The reason for this is that, if the whole population intends to withdraw at date 1, liquidating early the long run investment does not suffice to pay all the withdrawals. That is, for sufficiently low r it must be that

$$x > b + rk \tag{9}$$

since $b = \lambda x$ and $\lambda \in (0, 1)$. The left hand side is the total per-capita amount of consumption (in dollars) if the whole population wants to withdraw in period 1. The right hand side is the total per-capita value (in dollars) of the bank assets in that period. This implies that the amount of dollars that the economy generates is strictly less than the demand of dollars. This implies that the Central Bank cannot meet this demand for dollars, so a currency crisis arises.

Perhaps the main contribution of the mentioned paper is that the optimal allocation is implemented *without runs* with a flexible exchange rate regime. A depreciation or devaluation of the peso decreases the incentives to withdraw early for patient agents. This last result can be viewed as a *threat* of devaluation, since in equilibrium there is no depreciation of the local currency (in other words, the exchange rate is always one in equilibrium). Chang and Velasco show that the first best allocation is implementable under a flexible exchange rate regime with a local lender of last resort that provides liquidity in pesos in period 1. The main result in [4], section 6, is the following.

Proposition 1 (Chang and Velasco [4]) *The first best allocation \bar{x} , \bar{y} , \bar{m} can be implemented through a banking system with flexible exchange rates and a local lender of last resort. Moreover this is the only equilibrium (runs cannot arise in equilibrium).*

Proof. See Chang and Velasco [4], propositions 6.1 and 6.2. ■

The intuition is simple. The first interpretation of this policy is that the Central Bank *commits* to a devaluation policy that depends on the observed number of consumers withdrawing in period 1. If the proportion of agents withdrawing at date 1 is larger than λ , then the exchange rate is set as a ratio of the actual proportion of consumers divided by λ . This action discourages patient consumers, who can do better by waiting until date 2. This policy ensures all waiting patient agents a higher consumption than the consumption for those who run in period 1. Since there is perfect commitment of the Central Bank to this in the first place, this argument eliminates incentives for runs.

Chang and Velasco provide a second interpretation. They do not assume a sequential service constraint at the Central Bank. Hence the exchange rate arises naturally from an auction. This interpretation implies an asymmetry between the presence of a sequential service constraint at the commercial bank and the absence of such a restriction at the Central Bank.³ This assumption in fact must be interpreted as a situation when the Central Bank let the exchange rate float.

If we adopt the first interpretation, a new issue arises. The authors assume (implicitly) that the Central Bank will devalue in the described way whenever the actual proportion of agents is larger than λ . The question is whether this action by the Central Bank is actually *credible*. In other words, does the monetary authority have the *incentives* to devalue in this manner, when perfect commitment to this policy is not guaranteed? The next section provides an answer to this question.⁴

III. Credibility and the Chang-Velasco Devaluation Policy

In order to discuss credibility I need to assume some objective function for the Central Bank. It seems natural to have an ex-post weighted average of utilities as the objective function. This resembles a typical social welfare function used in the general equilibrium literature. I also need to endow some action space to the monetary authority in order to discuss credibility. Suppose that a proportion $\lambda^r > \lambda$ of agents arrive at the banks at date 1 to withdraw their money. If the Central Bank applies the described devaluation policy, recalling that $\chi(0) = 0$, I define the ex-post welfare

³ See Wallace [8]

⁴ In fact, the same credibility problem arises with the second interpretation. Suppose that *originally* the Central Bank announces that a floating exchange rate policy will take place at date 1. Assume that a bank run arises. Is it *optimal* for the Central Bank to let the exchange rate float? This question is homeomorphic to the one asking whether a devaluation policy is optimal given a run. Therefore, the arguments given in this paper can also be applied to the case of a floating exchange rate.

function as

$$U^d(\lambda^r) = \lambda^r g\left(\left(\frac{\lambda}{\lambda^r}\right)x\right) + (1 - \lambda^r) g\left(\chi(\bar{m}) + \frac{Rk}{1 - \lambda^r}\right) \quad (10)$$

This is just a weighted average of the utilities of those who withdraw and those who do not. The allocations x, b, k and \bar{m} correspond to the solution of the planner's problem. On the other hand, if the Central Bank does not apply the devaluation policy the ex-post utility is just

$$U^n = \bar{\lambda}g(x) + (1 - \bar{\lambda})g(0) \quad (11)$$

where $\bar{\lambda} > \lambda$ is $\bar{\lambda} \equiv (b + rk)/x$.⁵ I will furthermore assume that $\lambda^r = 1$, since the focus is on devaluation threats to prevent bank runs (which occur when $\lambda^r = 1$). Recall that at date 1 the commercial banks have $b + rk$ dollars available to pay to depositors, including the value of early liquidation of long run investments. Given that the optimal allocation is to be implemented, if there is no devaluation of the peso the exchange rate is fixed to 1 but the Central Bank works as a local lender of last resort. Given that each commercial bank only has $b + rk$ dollars to sell to the Central Bank, all commercial banks must indeed liquidate all long term investments in the presence of a run. In this case, only a proportion $\bar{\lambda}$ of the total population can get $x (> 0)$ dollars. The rest of agents that withdraw early gets exactly zero dollars (and zero goods). This happens because, with fixed exchange rates but with a local lender of last resort, there must be a currency run, which indeed implies a virtual *infinite* devaluation of the local currency, implying that the peso is worth nothing in terms of dollars. Hence, by a non-devaluating policy I really mean the situation when the Central Bank maintains the peg (even though $\lambda^r = 1$) selling all dollar reserves at an exchange rate of one, until they are all liquidated, followed by an infinite depreciation of the peso. The devaluation policy refers to the case where the Central Bank sells dollars at an exchange rate strictly greater than one.

The problem posted here constitute a time-inconsistency example. What seems optimal on an ex-ante basis may not be optimal on an ex-post basis. This is the core of the problem stated in this section.

With these conditions I can state a definition for a threat of devaluation to be non-credible.

Definition 1 *A threat of devaluation as described in the text is said to be **credible** if*

$$U^d \geq U^n$$

⁵ The fact that $b = \lambda x$ implies that $\bar{\lambda} = \frac{\lambda x + rk}{x} = \lambda + \frac{rk}{x}$. Since r, k and x are strictly positive, then $\bar{\lambda} > \lambda$.

Otherwise the threat of devaluation is said to be **non-credible**.

This states that the Central Bank devalues the peso only if the inequality above holds. Otherwise no devaluation of the peso takes place. Hence under a non-credible threat bank runs and/or currency crises are not avoided because the Central Bank *prefers* a run against the financial system and even against the local currency rather than to devalue in the way indicated by CV.

Credibility and Illiquidity of Long-Term Assets

The next result shows that when r is sufficiently small the threat of devaluation is credible.

Proposition 2 *If r is sufficiently close to zero, then the threat of devaluation is credible.*

Proof. The proof actually works for any $\lambda^r \in (\lambda, 1]$. With $r = 0$ we have that $\bar{\lambda} = \lambda$. Suppose $\lambda^r < 1$. Since $\lambda^r > \lambda$, then:

$$\begin{aligned}
 U^d(\lambda^r) &= \lambda^r g\left(\left(\frac{\lambda}{\lambda^r}\right)x\right) + (1 - \lambda^r) g\left(\chi(\bar{m}) + \frac{Rk}{1 - \lambda^r}\right) \\
 &> \lambda^r g\left(\left(\frac{\lambda}{\lambda^r}\right)x\right) + (1 - \lambda^r) g\left(\chi(\bar{m}) + \frac{Rk}{1 - \lambda}\right) \\
 &\geq \lambda^r g\left(\left(\frac{\lambda}{\lambda^r}\right)x\right) + (1 - \lambda^r) g(x) \\
 &> g\left(\left(\frac{\lambda}{\lambda^r}\right)x\right) > g(\lambda x) > \lambda g(x) + (1 - \lambda) g(0) \\
 &= U^n
 \end{aligned} \tag{12}$$

The first inequality holds because $1/(1 - \lambda^r) > 1/(1 - \lambda)$, the second one is a consequence of the incentive compatibility condition (that holds at the optimum), the third inequality holds since $\lambda^r > \lambda$, and the fourth one from the fact that $\lambda^r < 1$. The last inequality uses concavity. If $\lambda^r = 1$, then

$$U^d = g(\lambda x) > \lambda g(x) + (1 - \lambda) g(0) = U^n \tag{13}$$

These two inequalities exhaust all possible cases for $r = 0$. Then in this case $U^d > U^n$. By continuity this last inequality holds for r sufficiently small. This ends the proof. ■

This proposition shows that when the long term asset is *very* illiquid, in the sense that the return of liquidating it early is too small, then it is always ex-post optimal for the Central Bank to devalue in the event of a run. This means that the threat proposed by Chang and Velasco is credible in the extreme illiquidity case (in the sense of Definition 1). However the level of illiquidity seems to be

restrictive. A more general result can be easily shown for $\lambda^r = 1$.

Proposition 3 *Assume that $\lambda^r = 1$. There exists a (unique) threshold value r^* such that, for all $r \leq r^*$ the inequality in definition 1 holds and for all $r > r^*$ it is not true. Hence for these latter values of r the threat of devaluation is not credible. The condition under which $r^* < 1$ is $[g(\lambda x) - g(0)]x < [g(x) - g(0)]e$.*

Proof. By definition $\bar{\lambda}(r)$ is a strictly increasing, affine function of r . This is because the value of b , k and x do not depend on r . Therefore when $\lambda^r = 1$ the function

$$\begin{aligned}\Phi(r) &\equiv U^n(r) - U^d \\ &= \bar{\lambda}(r)g(x) + (1 - \bar{\lambda}(r))g(0) - g(\lambda x)\end{aligned}\tag{14}$$

is strictly increasing in r . By proposition 2 we know that $\Phi(0) < 0$. By the fact that $\bar{\lambda}(r)$ is affine in r with $g(x) > g(0)$ then for sufficiently large r , $\Phi(r) > 0$. Standard continuity arguments ensure then the existence and uniqueness of the threshold r^* . At this value $\bar{\lambda}(r^*)[g(x) - g(0)] = g(\lambda x) - g(0)$. By construction of $\bar{\lambda}(r)$ this equality implies:

$$r^* = \frac{1}{k} \left\{ \frac{[g(\lambda x) - g(0)]x}{[g(x) - g(0)]} - b \right\}\tag{15}$$

Hence $r^* < 1$ if and only if $[g(\lambda x) - g(0)]x < [g(x) - g(0)]e$, since $b + k = e$ in the first best allocation. This ends the proof. ■

An interesting implication of this result is that it describes when the devaluation threat proposed in Chang and Velasco [4] is effective to achieve the first best without runs in a *credible* way. The policy maker is able to impose this threat only if the liquidity of the long term asset is at most given by the value r^* . On the other hand this value r^* depends on the amount invested in each asset as well as a measure of relative utilities for impatient agents between a devaluation vis-a-vis a non devaluation scenario. Notice that in the case in which preferences are represented by a utility function such that at the first best its value is null, then the threat is always credible independently of the illiquidity of the long term asset. This last remark seems somewhat special, although it remains to be explored in a general way.

The last result is easily generalizable for any λ^r in a neighborhood of 1. The following result gives this.

Proposition 4 *If $\lambda^r = 1$, there exists a (unique) threshold value r^* such that, for all $r \leq r^*$ the inequality in definition 1 holds and for all $r > r^*$ it is not true. Hence for these latter values of r the threat of devaluation is not credible. The condition under which $r^* < 1$ is $\{g[\lambda x] - g(0)\} x < [g(x) - g(0)] e$.*

Proof. It is clear that if $\lambda^r = 1$, and if $U^d > 0$ then the function $\Phi(r) \equiv U^n(r) - U^d$ is affine, strictly increasing in r , since U^d does not depend on r . By proposition 2 we have $\Phi(0) < 0$. On the other hand $\Phi(\hat{r}) > 0$ for a sufficiently high \hat{r} . Then there is a unique r^* such that $\Phi(r^*(\lambda^r)) = 0$. The expression for r^* is trivially obtained from the equality

$$r^* = \frac{1}{k} \left\{ \frac{(U^d - g(0)) x}{g(x) - g(0)} - b \right\} \quad (16)$$

where $U^d \equiv g[\lambda x]$. Then the obvious inequality to get $r^* < 1$ is $[U^d - g(0)] x < [g(x) - g(0)] e$, the inequality in the statement of the proposition. This ends the proof. ■

This result also gives a threshold illiquidity value above which the CV devaluation threat is non-credible. This threshold value depends on the proportion of consumers withdrawing at date 1.

Some remarks about the timing of information are necessary. In the exercise performed here the actual proportion of consumers withdrawing early is known before deciding on the exchange rate in period 1. This assumption is in accordance with the original framework. This seems not to be strong in the discussion of this paper. This is so because consumers sell pesos for dollars after closing the withdrawing session at the commercial banks. Hence it is logically consistent that the Central Bank can observe the actual proportion of the population who get funds at date 1.

An Example with CRRA Preferences

Assume that the utility function $g(z) = z^{1/2}$. Assume also that

$$\chi(m) = -\frac{1}{2}m^2 + 2m \quad (17)$$

so that the first best level of pesos is 2. In this case the first best consumption allocations and portfolio are the following.

x^*	y^*	b^*	k^*
$\frac{e + \frac{2(1-\lambda)}{R}}{\lambda + R(1-\lambda)}$	$\left(\frac{\lambda}{\lambda + R(1-\lambda)}\right) \left(\frac{R^2 e}{\lambda} - 2\right)$	$\frac{\lambda(e + \frac{2(1-\lambda)}{R})}{\lambda + R(1-\lambda)}$	$\left(\frac{\lambda(1-\lambda)}{(\lambda + R(1-\lambda))R}\right) \left(\frac{R^2 e}{\lambda} - 2\right)$

I characterize now the threshold value r^* in this case when there is a threat of a run. The value of $\bar{\lambda}$

is given by

$$\bar{\lambda} = \frac{eR[\lambda + Rr(1 - \lambda)] + 2(1 - r)\lambda(1 - \lambda)}{eR + 2(1 - \lambda)}$$

Therefore the CV devaluation policy is credible as long as

$$\left\{ \frac{\left(e + \frac{2(1-\lambda)}{R} \right) \lambda}{\lambda + R(1 - \lambda)} \right\}^{1/2} \geq \left(\frac{eR[\lambda + Rr(1 - \lambda)] + 2(1 - r)\lambda(1 - \lambda)}{eR + 2(1 - \lambda)} \right) \left\{ \frac{e + \frac{2(1-\lambda)}{R}}{\lambda + R(1 - \lambda)} \right\}^{1/2} \quad (18)$$

which holds if and only if

$$\lambda^{1/2} [eR + 2(1 - \lambda)] \geq eR[\lambda + Rr(1 - \lambda)] + 2(1 - r)\lambda(1 - \lambda) \quad (19)$$

Therefore the threshold value r^* is given by

$$r^* = \frac{[eR + 2(1 - \lambda)] \lambda^{1/2} [1 - \lambda^{1/2}]}{(1 - \lambda)(R^2 e - 2\lambda)} \quad (20)$$

First, note also that, in order to get $r^* > 0$ we must have $R^2 e > 2\lambda$. The following result gives a sufficient condition to get $r^* < 1$.

Claim. *In the example above, the threshold value is strictly less than one for sufficiently large values of eR .*

Proof. Note that $r^* < 1$ if and only if

$$2(1 - \lambda)\lambda^{1/2} < eR \left[R(1 - \lambda) - \lambda^{1/2} (1 - \lambda^{1/2}) \right] \quad (21)$$

Therefore, the right hand side clearly increases with both e and R , since $\lambda^{1/2} > \lambda$ (because λ is less than one) and so $1 - \lambda > 1 - \lambda^{1/2}$, and given that $R > 1$, the expression $\left[R(1 - \lambda) - \lambda^{1/2} (1 - \lambda^{1/2}) \right]$ is always strictly positive, and so the right hand side increases with eR . ■

This states that under the preferences presented in this example, whenever the return on the long asset or the endowment of the consumer is big enough, then the threshold liquidity value is less than one. This implies that there is a positive Lebesgue measure of values of r such that the devaluation policy proposed in CV is not credible. The measure of these values of r is greater the larger is eR since it easy to show that $\partial r^* / \partial (eR) < 0$. Therefore, the range under which the threat is not credible increases with either the long run asset return or the consumer's endowment.

The next question that one can answer is the following. If the policy is not credible (which is true for the cases described above), is there an alternative devaluation policy that is credible, *given the same informational assumptions than in the Chang and Velasco framework?* The following section shows that this is the case.

IV. A Credible Devaluation Threat

This section proposes a new devaluation threat that prevents runs implementing the first best with the addition that it does not violate the credibility condition explained above. This devaluation works similar to the one in CV but the devaluation rate is not the same. It also involves some early liquidation of the long term asset. Suppose that the exchange rate regime is summarized by the following expression:

$$E_1 = \begin{cases} 1 & \text{if } \lambda^r = \lambda \\ \bar{\lambda}^{-1} & \text{if } \lambda^r > \lambda \end{cases} \quad (22)$$

where $\bar{\lambda}$ is the value of λ defined above. At date 2 we still have $E_2 = 1$. The following result shows that, under reasonable conditions on function χ , this policy is enough to prevent runs but now in a credible way. (This result is shown for any value of λ^r strictly greater than λ).

Proposition 5 *Assume that the exchange rate regime at date 1 follows the pattern above. If $\lambda^r > \lambda$ then this policy prevents runs and it is credible in the sense of definition 1.*

Proof. The proof has two parts. First I show that this policy prevents runs and then I show that is credible. First, assume that $\lambda^r > \bar{\lambda}$. This implies that the exchange rate at 1 is $\bar{\lambda}^{-1}$. I show that, under this exchange rate, a patient individual wants to wait until period 2. First, if a proportion λ^r of agents withdraw at date 1, the commercial bank must liquidate an amount \bar{l} of the long term asset, satisfying

$$\begin{aligned} \lambda^r \bar{\lambda} x &= b + r \bar{l} \\ &= \lambda x + r \bar{l} \end{aligned} \quad (23)$$

Thus

$$\begin{aligned} \bar{l} &= \frac{(\lambda^r \bar{\lambda} - \lambda)}{r} x \\ &= \frac{(\lambda^r (\lambda x + rk) - \lambda x)}{r} \end{aligned} \quad (24)$$

In period 2, total amount of per-capita dollars is equal to:

$$\begin{aligned}
 & R \left(k - \frac{(\lambda^r (\lambda x + rk) - \lambda x)}{r} \right) \\
 &= \frac{R}{r} (rk + \lambda x (1 - \lambda^r) - \lambda^r rk) \\
 &= \frac{R}{r} (rk (1 - \lambda^r) + \lambda x (1 - \lambda^r))
 \end{aligned} \tag{25}$$

Assume $Q = E_2 = 1$. Then patient depositors deliver $(1 - \lambda^r) \bar{M}$ to bank at date 2. Also we know that each patient gets

$$\begin{aligned}
 y^r &= \frac{R (rk (1 - \lambda^r) + \lambda x (1 - \lambda^r))}{r (1 - \lambda^r)} \\
 &= \frac{R}{r} (rk + \lambda x) = \frac{R}{r} (rk + b) \\
 &= \frac{R}{r} \bar{\lambda} x
 \end{aligned} \tag{26}$$

But then

$$\begin{aligned}
 y^r + \chi(\bar{M}) &= \frac{R}{r} \bar{\lambda} x + \chi(\bar{M}) \\
 &> \bar{\lambda} x + \chi(\bar{M}) \\
 &> \bar{\lambda} x
 \end{aligned} \tag{27}$$

since we assume that $\chi(0) = 0$. Hence every patient consumer prefers to wait until date 2 instead of running against the commercial banks.

Next I show that this threat is credible, in the sense that the Central Bank prefers to apply this rather than to let the bank system fail. It is enough to show this whenever $\lambda^r > \bar{\lambda} > \lambda$. In this case, the ex-post utility of the Central Bank is given by

$$\begin{aligned}
 & \lambda^r g(\bar{\lambda} x) + (1 - \lambda^r) g(\chi(\bar{M}) + y^r) \\
 &> \lambda^r g(\bar{\lambda} x) + (1 - \lambda^r) g(\bar{\lambda} x) \\
 &= g(\bar{\lambda} x) \\
 &> \bar{\lambda} g(x) + (1 - \bar{\lambda}) g(0)
 \end{aligned} \tag{28}$$

where the first inequality is given by the proof above, and the last inequality is given by strict

concavity of g . The last expression is the ex-post utility of the Central Bank if this institution does not devalue and the bank system fail. Hence for any $\lambda^r > \bar{\lambda}$ then it is incentive-compatible for the bank to apply this policy. Therefore this is a credible threat. ■

Note that this proposition applies to the special case in which $\lambda^r = 1$, which is the relevant case to prevent *authentic* bank runs (events where *all* agents try to withdraw early). This result shows that it is always possible to apply an exchange rate threat that is credible. Notice that the Central Bank liquidates a portion of the long run asset when applying the threat. This allows to pay the impatient consumers a higher dollar consumption quantity than under the CV flexible exchange rate. This is the key to understand why there is no credibility issue under this case.

V. Concluding Remarks

To my knowledge this note is the first work to address credibility problems in the context of the classical Diamond and Dybvig framework. This constitutes a first step in terms of discussing the links between bank system liquidity, on one side, and credibility of exchange rate regimes on the other. Although it does not answer the question of comparing credibility gains of fixed exchange rates versus liquidity in the banking system, it does answer the credibility problems that the Central Bank faces when applying a flexible exchange rate regime to allow for the social optimum implementation.

Credibility issues in terms of bank-runs prevention may also arise in closed economies. For example, the standard policy of total suspension of convertibility of deposits may also be subject to this analysis. This means that it is possible that total suspension of convertibility may not be credible as well. However the timing of information given in the Chang and Velasco model seems not to be natural here. Recall that total suspension means that commercial banks themselves stop paying off to consumers after a measure of the population equal to the proportion of impatient agents withdraw from intermediaries. It seems much stronger here (due to the sequential service constraint assumption) to assume that commercial banks can observe the *total* proportion of withdrawals before deciding whether to apply the total suspension. In fact this seems to be inconsistent with the sequential service constraint. Further research needs to be done in this line.

In the literature there are still puzzling features. Green and Lin [7] have recently shown that, when the number of traders is finite, then a unique Bayesian equilibrium exists. This equilibrium implements the social optimum without runs. Hence it is crucial to characterize more completely

the types of contracts in the context of open economies as well. I leave this as future research. Also, as CV pointed out, the way preferences for local currency are modelled is highly arguable. It is possible that the same arguments that worked here would also be true under more general money-in-the-utility-function models. A better way of modelling a role for pesos may include a non-tradeable good, as in Chang and Velasco do. This is left for future research. Finally, endogeneizing the liquidation values of long term investments is also another important topic to be considered in open economies. In this regard, the line of research developed by Allen and Gale in several papers (1998, 2001) endogeneizes the asset returns by including security markets. These attempts have been done in closed economies. Applications of these ideas to open economies and their interactions with exchange rates constitute important extensions.

REFERENCES

- [1] Allen, Franklin and Douglas Gale (1998). “Optimal Financial Crises”, *Journal of Finance* 53, 1245-1284.
- [2] Allen, Franklin and Douglas Gale (2001). “Banking and Markets”, Working Paper 00-44-B, Financial Institutions Center, The Wharton School.
- [3] Chang, Roberto and Andrés Velasco (1999). “Liquidity Crises in Emerging Markets: Theory and Policy”, in *NBER Macroeconomics Annual 1999* (Ben Bernanke and Julio Rotemberg, eds.), The MIT Press, Cambridge.
- [4] Chang, Roberto and Andrés Velasco (2000). “Financial Fragility and the Exchange Rate Regime”. *Journal of Economic Theory* 92; 1-34.
- [5] Diamond, Douglas and Phillippe Dybvig (1983). “Bank Runs, Deposit Insurance, and Liquidity”. *Journal of Political Economy*, 91, 401-419.
- [6] Freixas, Xavier and Jean-Charles Rochet (1997). *Microeconomics of Banking*, Cambridge MA, MIT Press.
- [7] Green, Edward and Ping Lin (2000). “Diamond and Dybvig’s Classic Theory of Financial Intermediation: What’s Missing?”. *Federal Reserve Bank of Minneapolis Quarterly Review* 24; 3-13.
- [8] Wallace, Neil (1988) “Another Attempt to Explain and Illiquid Banking System: The Diamond and Dybvig Model with Sequential Service Taken Seriously”, *Federal Reserve Bank of Minneapolis Quarterly Review* 12, pp. 3-16.

**UNA NOTA SOBRE LA CREDIBILIDAD DE POLÍTICAS DEVALUATORIAS
PREVENTIVAS DE CORRIDAS BANCARIAS**

ENRIQUE KAWAMURA

RESUMEN

Clasificación JEL: G21, G28

En esta nota proveo una noción de una política devaluatoria creíble en el contexto del modelo de Chang y Velasco (2000). Muestro que cuando el activo de largo plazo es lo suficientemente ilíquido, una política de tipo de cambio flexible es creíble. También se muestra que existe un rango no trivial para el valor de liquidación de la tecnología de inversión de largo plazo para el cual la misma política no es creíble. Finalmente, propongo un régimen diferente de tipo de cambio flexible que se demuestra creíble.

**A NOTE ON THE CREDIBILITY OF BANK-RUN-PREVENTING
DEVALUATION POLICIES**

ENRIQUE KAWAMURA

SUMMARY

JEL Classification: G21, G28

In this note I provide a notion of a credible devaluation policy in the context of the Chang and Velasco (2000) model. I show that when the long term asset is illiquid enough a flexible exchange rate policy is credible. It is also shown that there exists a non-trivial range for the liquidation value of the long term investment technology for which the same policy is not credible. Finally I propose a different flexible exchange rate regime which is shown to be credible.