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A BANK-RUN PERSPECTIVE

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ABSTRACT

This note is motivated by trying to understand the macroeconomic implications of assuming that periods of financial bonanza and turmoil are driven by financial innovation and collapse in line with the "bank run" literature of the Diamond-Dybvig (1983) variety. Bypassing a host of important but, for the present purposes, secondary details the note assumes that the initial effects of financial innovation and crash can be summarized by a parameter that determines the "liquidity" or "moneyness" of land or capital. This simplification helps to shed light on some issues that are at the center of the policy debate. In particular, one can show that preventing price deflation is not enough to offset asset meltdown. Furthermore, lower policy interest rates increase asset prices and steady-state output which, however, gets reversed as liquidity is destroyed. An interesting result is that, in the neighborhood of a first-best capital allocation, an increase in the moneyness of capital may lower the welfare of the representative individual, even if the higher liquidity of capital is sustainable and, hence, not destroyed by future crash. Moreover, an extension of the basic model supports the conjecture that low policy interest rates may have given incentives to the development of "shadow banking."

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I. Introduction

Few would deny that we are living in extraordinary times. Where opinions start to differ is about what is behind current events. The popular press, not surprisingly, stresses fraud and crony capitalism, while better informed observers blame inadequate financial supervision. Both have a share of the truth. However, these opinions may miss a central fact, namely, that financial systems are, as a general rule, prone to eventual collapse if they don't have a "lender of last resort," LOLR. Diamond and Dybvig (1983) made that point in terms of a simple and elegant banking model (for a recent exposition, see Diamond (2007)). Thus, under this optic the present financial troubles could be traced to the existence of a "shadow" banking system that developed without enough supervision and, critically, without a LOLR. This is the main conjecture that inspires the present note.[1] A second conjecture is that the shadow system succeeded in "printing money" through devices like collateralized debt obligations, CDOs. This is formalized by assuming that financial innovation succeeded in making *land* or *capital* more "liquid," e.g., by making them more useful as a means of payment. These assumptions or conjectures are then employed to trace the general equilibrium implications of an increase or collapse in land's or capital's liquidity – the central comparative-dynamic exercise – in a rational expectations setup.[2]

There are many models in which capital market imperfections contribute to make business cycle fluctuations deeper and more persistent (see, for example, Bernanke and Gertler (1989) and Kiyotaki and Moore (1997)). This literature stresses agency problems

[1] See Brunnermeier (2008) for a highly didactic exposition of the Subprime crisis that supports the view that the financial collapse has Diamond-Dybvig characteristics.

[2] Rational expectations may look like an awkward vessel to encapsulate the discussion. However, in this paper liquidity crises are taken as exogenous and unanticipated. Thus, our agents will be rational but ignorant of the central driving force, i.e., the sudden demise of liquidity-enhancing financial instruments.

in which first-best credit allocation is not achieved because of, for instance, asymmetric information of debtors and creditors. A financial crisis of the kind we are experiencing could be modeled in that context by assuming that there is a sudden deterioration in agency problems. There is no doubt that the Subprime crisis itself has contributed to worsening the creditworthiness of individuals and firms but it would be hard to argue that the initial kick was given by a sudden deterioration of agency problems. Financial institutions increasingly engaged in non-transparent activities but this did not occur overnight; these activities took years to reach pre-crisis characteristics. Thus, available models fail to meet a central analytical challenge for rationalizing the current crisis, namely, developing a case in which behavior discontinuity could be justified in an intuitively plausible manner.[3] The challenge is better met by the model discussed in this paper, because the Diamond-Dybvig bank-run story which underlies the model displays equilibrium multiplicity (in absence of a LOLR).[4] A financial crisis could erupt just because people *expect* that other people expect that financial instruments issued by shadow banks will be bereft of liquidity. This equilibrium fragility is not obtained by superimposing an ad-hoc assumption to the original model (as it would be the case in the asymmetric-information approach),[5] but as a result of an essential characteristic of the underlying bank-run model. No *real* shock is needed for crisis to happen in this context. Thus, the model provides a rationale for the fact that the triggers behind big-time financial crises in the 30s and late 80s – and even the Subprime crisis' global

[3] This challenge is also faced by the literature on Sudden Stops in emerging capital markets (see Calvo (2007). The challenge is less critical, however, because the initial kick took place *outside* most of emerging capital markets.
[4] Granted, central banks eventually came to the rescue of "shadow banks," but their action would have been much more timely and effective, had rescue operations clearly been mandated in their charters.
[5] It would not be hard to generate equilibrium multiplicity in asymmetric-information models. However, macro models in that vein do not explore that feature and, thus, implicitly assume uniqueness of equilibrium.

ramifications, not just crisis in the tiny subprime mortgage market – are so hard to identify. In addition, the model puts a concept like "liquidity" up front in an explicit and straightforward manner. This is important given the relevance of liquidity issues in current debate.[6]

Implications are straightforward and serve to highlight the macroeconomic impact of phenomena like financial innovation and meltdown. In particular, in the basic model, in which land is in fixed supply, an increase in land's liquidity increases its relative price, helping to explain a run-up on real estate prices triggered by financial innovation. Likewise, a financial meltdown results in a sharp decline in land price – a bursting of the bubble explained by underlying *financial fundamentals*, not Ponzi games. Moreover, the model shows that preventing price deflation may fall short of avoiding serious financial difficulties because the policy may be incapable of restoring the relative price of land.

Moving from land to capital and allowing capital to accumulate in a neoclassical manner, I will show that higher capital's liquidity brings about capital accumulation and higher output. This is in line with the literature supporting the view that financial development and output growth are positively correlated (see, e.g., Demirgüç-Kunt and Levine (2008)). However, I will show an example in which increasing the liquidity of capital may be detrimental to social welfare, even ignoring the social costs of an eventual liquidity crunch. Moreover, left to its own devices, the financial sector becomes suboptimally large. The example, however, presupposes that capital allocation is not hampered by distortions and could achieve the first-best allocation in absence of financial intermediaries. Otherwise, enhancing the liquidity of capital could be socially beneficial. This suggests that liquidity enhancements could be especially helpful in the context of

[6] An analytical advantage of the present approach is that it displays an extremely simple dynamic structure.

highly distorted capital markets, if the probability of a financial meltdown can be kept sufficiently low.

The model is extended to study the impact of central bank's interest rate policy. Following Calvo and Vegh (1995), the central bank's policy is made equivalent to paying interest on money, where the interest rate is the central bank's policy interest rate, e.g., the Fed's Federal Funds Rate. In this setup, the central bank could raise the relative price of land by lowering interest rates, even though monetary policy is conducted under perfectly flexible prices.

The model is capable of rationalizing the statement made by several observers that Greenspan's lax monetary policy after September 2001 is responsible for the housing bubble, at least in the U.S. (see Taylor (2009)). Of course, if that explains the bubble, raising interest rates would have burst the bubble, which helps to explain (but not justify) Greenspan's reluctance to raising interest rates. More generally, this result supports the view that monetary policy could be effective in lowering the costs of an eventual financial meltdown by timely raising interest rates, and thus putting a damper on asset prices.

The note is closed with a summary of central implications.

II. The Basic Model

Consider a standard infinitely-lived, representative-individual model with time-separable utility. The instant utility function depends on consumption c and liquidity; liquidity is produced by real monetary balances (in terms of consumption), m, and pk, where k and p stand for land and its price (relative to consumption), respectively. More concretely, liquidity (in terms of consumption) = $m + \theta pk$, $0 \leq \theta < 1$, where θ is an index of the "moneyness" of land (the linear form is assumed to simplify the exposition and without loss of generality). This assumption is central, and represents the main expository innovation in this paper. It captures a central macroeconomic implication of the Diamond-Dybvig model, namely, that financial intermediaries enhance the liquidity of real factors of production. But, at the same time, in absence of a LOLR or equivalent arrangement, such liquidity could quickly evaporate in a bank run, possibly causing credit unraveling and output collapse. Thus, parameter θ increases the liquidity of land when it rises, but it could as well destroy it when it falls.[7] The literature has focused on arrangements to avoid this "bad" equilibrium, but the macroeconomic implications of liquidity swings have remained relatively unexplored. The present paper attempts to start filling that gap.[8]

At time 0, the utility function takes the following form:[9]

$$\int_0^{\infty} [u(c_t) + v(m_t + \theta p_t k_t)] e^{-\delta t} dt, \ \ \delta > 0 \tag{1}$$

where utility indexes u and v are twice-differentiable, strictly concave and increasing over the positive interval, and $\delta > 0$ stands for the constant subjective rate of discount.

At time t the individual's financial wealth in terms of consumption, a, satisfies:

$$a_t = m_t + p_t k_t + b_t, \tag{2}$$

[7] Notice that, by making $\theta < 1$, real assets are inferior transaction vehicles that would never be demanded as such if they were unproductive. This ensures that multiple equilibrium à la Kareken and Wallace (1981) does not hold in this model despite the linearity assumption.

[8] Interestingly, the link between liquidity and crisis appears to have been largely ignored in the growth literature. For example, in a useful recent survey of the literature, Demirgüç-Kunt and Levine (2008) discuss several theories establishing the link between liquidity and growth without mentioning the possibility that liquidity could be conducive to financial crisis.

[9] Time 0 denotes the start of the planning period, and does not refer to a fixed calendar time. The individual will thus face the same utility function as he/she replans in the future.

where b denotes the stock of (instant maturity) "pure" bonds, i.e., bonds that are not a source of liquidity, in terms of consumption. The instantaneous real interest rate on pure bonds is denoted by r.

Output y is produced by land, and the production function is linear and satisfies $y = \rho k$, where ρ is a positive constant. Therefore, the evolution of financial wealth a satisfies:

$$\dot{a}_t = (\rho + \dot{p}_t)k_t + r_t b_t - c_t - \pi_t m_t + \sigma_t \tag{3}$$

where π stands for the instantaneous (consumption) rate of inflation, and σ denotes lump-sum subsidies; seigniorage is fully rebated to the public and will equal σ. For simplicity and without loss of generality, the government is assumed to hold no net wealth.

Using equations (2) and (3) and ruling out Ponzi games, one obtains a familiar intertemporal budget constraint:

$$\int_0^\infty c_t e^{-\int_0^t r_s ds} dt = a_0 + \int_0^\infty [(\rho + \dot{p}_t - r_t p_t)k_t + \sigma_t - (\pi_t + r_t)m_t] e^{-\int_0^t r_s ds} dt. \tag{4}$$

Notice that $\pi + r$ = nominal interest rate = opportunity cost of holding real monetary balances; and $rp - (\rho + \dot{p})$ is the opportunity cost of holding land, rp, minus its return, $\rho + \dot{p}$.

Remark 1. The above budget constraint assumes the existence of perfect capital markets, an assumption that may sound implausible given that the model is intended to cast light on financial crises. This apparent weakness of the model, though, has the advantage of helping to show that liquidity effects *by themselves* go a long way in explaining real-estate bubbles and other stylized facts of financial crises.[10]

Maximization of utility (1) with respect to c, k and m, given initial condition a_0 and the path of the pure interest rate r, subject to budget constraint (4), yields the following first-order conditions:

$$
\begin{aligned}
&u'(c_t) = \lambda D_t && \text{(a)} \\
&v'(m_t + \theta p_t k_t) = \lambda(\pi_t + r_t) D_t && \text{(b)} \qquad (5) \\
&v'(m_t + \theta p_t k_t)\theta p_t = -\lambda(\rho + \dot{p}_t - r_t p_t) D_t && \text{(c)}
\end{aligned}
$$

where λ is the Lagrange multiplier (a constant) corresponding to constraint (4), and $D_t = e^{\int_0^t (\delta - r_s) ds}$.

In what follows I will focus on interior solutions, make some inconsequential simplifications, and skip some obvious steps in order to streamline the presentation. I will assume that the supply of land is constant overtime, and the subjective rate of discount equals land's marginal productivity, i.e., $\delta = \rho$. Moreover, I will assume that nominal money supply is constant over time (this will be relaxed in Section III.1). One can show that these assumptions ensure that the steady state is the only converging equilibrium path, and that equilibrium inflation $\pi = 0$.[11] Correspondingly, and without loss of generality, the following analysis will focus on steady states.

From equations (5b) and (5c), we have, setting $\dot{p} = 0$,

[10] This model strategy is similar to that followed in several papers addressing the Great Depression and the current crisis. See, for example, Cole and Ohanian (2004).

[11] See Calvo (1979) for a more detailed analysis of monetary models with perfect foresight. Using similar techniques, one can show that the present model boils down to two differential equations (in *m* and *p*), with no initial conditions. The linear approximation at the steady state displays two positive characteristic roots, which ensure that the only converging equilibrium path is the steady state.

$$p = \frac{1}{1-\theta},\ 0 \le \theta < 1. \quad [12] \tag{6}$$

An alternative, more direct and intuitive, derivation of equation (6) is as follows. At optimum, the representative individual must be indifferent between holding an additional unit of liquidity in any of the two available instruments: money or land. One additional unit of liquidity in the form of land calls for setting $d(\theta pk) = 1$, which implies that $d(pk) = 1/\theta$ and $dk = 1/\theta p$, where d denotes the differentiation operator. Therefore, the cost of the additional unit of land is $rd(pk) - \rho dk = r/\theta - \rho/\theta p$; the first term in each of the last two expressions is the opportunity cost of holding land, $rd(pk)$, while the second, ρdk, is its return. On the other hand, the cost of holding an additional unit of money is just r, given that the equilibrium inflation rate is zero. Equation (6) follows from equating the marginal costs of land and money, and recalling that at steady state $r = \delta = \rho$.

Hence, if land offers no liquidity services, $\theta = 0$, the equilibrium price of land would be $p = 1$. On the other hand, if $\theta > 0$, the price of land $p > 1$ and rises with θ. This result is intuitive because liquidity services add value to land holdings. In a dynamic setting in which θ rises over time (expectedly or not), one can show that land prices will be increasing over time.

Consequently, this model can explain higher land's relative price as a result of financial engineering that makes land or derivatives associated with land (e.g., CDOs) more liquid. However, like in the standard banking model without a LOLR, there could exist a "bad" equilibrium in which, for example, θ collapses to 0. Thus, the present

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[12] Notice that to ensure that $m > 0$, it follows from equations (5) and (6) that $m = \varphi(u'(\rho k)\rho) - \frac{\theta}{1-\theta}k > 0$, where φ is the inverse of v'. This can always be ensured by appropriate choice of functions u and v, given θ.

model has all the basic ingredients to produce price bubbles geared to the expansion and collapse of the financial sector (this is fully in line with the empirical findings in Taylor (2009)). Notice that by increasing money supply (or QE, quantitative easing) the monetary authority could help to prevent price deflation. However, that policy will have no effect on the price of land *relative* to consumption. Thus, preventing price deflation may not save the economy from financial turmoil associated with the collapse of some key relative price.[13]

A once-and-for-all increase in government consumption financed by lump-sum taxes has, by equation (6), no impact on the relative price of land *p*. This holds even if taxes are raised to buy land. Thus, in this context a fiscal stimulus package would be neutral.[14]

Remark 2. Short-run impact on output from a fall in θ could easily be generated by inserting liquidity as a factor of production, following Fischer (1974), for example. In this fashion, the model would display output collapse as θ falls after a bank run, for example.

III. Extensions of the Basic Model

The basic model can be extended in several interesting directions, as illustrated by the following examples.

1. Interest Rate Policy. Monetary policy in advanced economies is not conducted by directly controlling monetary aggregates but, instead, by manipulating a key (usually short term) interest rate. Consider the type of model developed in Calvo and Vegh (1995) in which the central bank interest rate would be equivalent to

[13] Under strict representative-individual conditions, a sudden change in relative prices does not cause financial trouble, because net borrowing is always zero. However, extensions to heterogeneous consumers with positive net lending are straightforward.

[14] Of course, distortionary taxes will have an effect on *p*, but that is not the main thrust behind a stimulus package.

paying interest on money.[15] Let the latter be denoted by i_m. The stock of money is assumed, once again, constant over time.[16] In contrast to much of the modern theory of monetary policy (see Woodford (2003)), I will assume that prices are perfectly flexible. This assumption is not prompted by realism, but by trying to focus as sharply as possible on the model's new ingredient, namely, liquidity of productive assets.

Thus, first-order condition (5b) would now read

$$v'(m_t + \theta p_t k_t) = \lambda(\pi_t + r_t - i_m)D_t \tag{5b'}$$

Hence, by equations (5b') and (5c), expression (6) becomes (noticing that at an interior equilibrium $i_m < \rho + \pi$)

$$\theta(\rho + \pi - i_m) = \rho\left(1 - \frac{1}{p}\right). \tag{6'}$$

Therefore, for a given π, a fall in i_m brings about an increase in the relative price of land p. The intuition is that a fall in the return on money i_m shifts demand for liquidity in favor of land, raising its price. This result can be used to rationalize the common statement that easy monetary policy in the U.S. could be blamed for contributing to the real-estate bubble; or to show that monetary easing could offset a meltdown in real estate prices if $\theta > 0$.

[15] This can be derived in a model in which m is a composite of non-interest-bearing and interest-bearing liquid assets, the latter being, for instance, short-term treasury bills, see Calvo and Vegh (1995). The Calvo-Vegh approach is an alternative to the more popular approach discussed at length in Woodford (2003), for instance, in which the monetary authority is typically assumed to control a "pure" short-run interest rate. The advantage of the Calvo-Vegh approach is that it does not imply arbitrage conditions (between, say, short- and long-run, or domestic and foreign interest rates) which are strongly rejected by empirical evidence (unless one is prepared to make assumptions on random errors that have no clear economic basis). For a recent application of this approach, see Canzoneri at al (2008).

[16] In terms of the model outlined in footnote 15, this assumption would be consistent with a situation in which the aggregate stock of the two types of monies is constant, but its composition is determined by the private sector taking into account the return on the interest-bearing component. This is consistent with standard procedures followed when interest rates are used as instruments for monetary policy.

Another policy that may succeed at lifting the relative price of land would be a helicopter-type monetary expansion at, say, a constant rate $\mu > 0$ in order to generate inflation – a policy advocated by Krugman for Japan in the 1990s (see Krugman (2009)). One can show that this implies that, once again, the unique converging equilibrium for the model is the steady state, and that the associated rate of inflation equals μ. Moreover, equation (6') becomes, setting $i_m = 0$,

$$(\rho + \mu)\theta = \rho\left(1 - \frac{1}{p}\right). \tag{6''}$$

Hence, an increase in μ yields a higher p, validating Krugman's conjecture. However, this policy as well as the interest rate policy examined above would fail in the extreme case in which land becomes totally illiquid, i.e., $\theta = 0$.[17]

On a separate note, notice that at steady state the rate of return on pure bonds is invariant to i_m. This straightforward result is interesting because it shows that the Calvo-Vegh approach is capable of rationalizing the famous "Greenspan's conundrum," i.e., a situation in which a rise in the policy interest rate has no impact on some of the other interest rates in the system.

2. Capital Accumulation. Suppose that variable k stands for physical capital, and that the latter can be accumulated without adjustment costs (being, thus, of the "putty-putty" variety). To ensure existence of a robust case of interior solutions, I will assume that the production function satisfies $y = f(k)$, where f is a standard strictly concave neoclassical production function. Focusing on interior solutions,

[17] It is worth noting that if $\theta = 0$, the model boils down to the standard model in which k yields no liquidity services. Therefore, the effects on the price of land stemming from central bank interest rates or inflation highlighted in the text would *not* hold in the standard model, showing that the results highlighted in this note are intimately linked to financial/liquidity considerations.

one can prove that starting at steady state, a once-and-for-all increase in the liquidity of capital, θ, will induce capital accumulation and higher steady-state welfare. Characterizing steady states is straightforward because first-order conditions (5) hold intact if one interprets ρ as the capital rental (no longer a parameter but an endogenous variable); thus, at a competitive no-distortions equilibrium $f'(k) = \rho$ and $p \equiv 1$ (because capital is putty-putty and, by assumption, the equilibrium solution is interior). Moreover, at steady state, we have that the rate of interest on pure bonds $r = \delta$, the subjective rate of discount. Hence, equation (6) becomes

$$f'(k) = \delta(1-\theta), \qquad (6''')$$

which, again, makes sense only for $\theta < 1$. Clearly, for positive θ, $f'(k) < \delta$; and the higher is θ, the higher will be steady-state capital k. This trivially shows that, despite its risks, financial liberalization may have some redeeming value.[18]

3. Welfare Effects of θ. In contrast, welfare, as measured by expression (1), may decline. To show this important implication in a simple manner, I will now turn to an open-economy version of the model in which the economy is open to frictionless trade and capital mobility. In addition, I will assume that the exchange rate is constant over time. To make things more interesting, I will assume that the policy interest rate is equivalent to paying interest on money (as in subsection 1); once again, I will denote it by i_m. Seigniorage, net of interest on money, is lump-sum rebated to the public, and the international price level is

[18] The role of banks in the creation of liquidity and in facilitating more productive investment projects is well understood in the literature, e.g., Diamond and Dybvig (1983), Allen and Gale (2007). The value added of the present model is to discuss the output effect in a standard neoclassical framework and, as I will next show, establish its welfare implications.

constant over time – implying that $\pi = 0$. Moreover, I will make the standard simplifying assumption in open macro models that the subjective rate of discount equals the international interest rate. This is equivalent to setting $\delta = r$.

Under these assumptions, it follows that first-order conditions (5) become (recalling that at equilibrium $p = 1$)

$$u'(c_t) = \lambda \qquad \text{(a)}$$

$$v'(m_t + \theta k_t) = \lambda(\delta - i_m) \qquad \text{(b)} \qquad (7)$$

$$v'(m_t + \theta k_t)\theta = \lambda[\delta - f'(k_t)]. \qquad \text{(c)}$$

It follows that c, m and k are constant over time and (6''') becomes

$$f'(k) = \delta(1-\theta) + i_m\theta. \qquad (6'''')$$

Moreover, since seigniorage is fully rebated, the budget constraint for the economy as a whole becomes (assuming, without loss of generality, that initial total financial wealth is zero)

$$\int_0^\infty [f(k_t) - \delta k_t - c_t]e^{-\delta t}dt = 0. \qquad (8)$$

Thus, since k and c are constant over time, we have

$$c = f(k) - \delta k \qquad (9)$$

We are now ready to examine the welfare implications of a once-and-for-all increase in the liquidity parameter θ. By equation (6''''), an increase in θ brings about an instantaneous increase in the capital stock k if the economy starts below Friedman's optimal quantity of money (i.e., if $\delta > i_m$), the case on which I will focus the following discussion. By (6'''') and (9),

$\partial c / \partial k = [f'(k) - \delta] = (i_m - \delta)\theta < 0$, if $\theta > 0$. In words, if capital is endowed with some degree of liquidity, equilibrium consumption falls as capital rises. Therefore, an increase in θ results in a fall in consumption c. Moreover, by (7a) and (7b), $v' = (\delta - i_m)u'(c)$. Hence, by concavity of functions v and u, the fall in c raises $u'(c)$, which by the equality expression in the previous sentence implies that at equilibrium v' rises and, hence, v falls. Consequently, both utility indexes u and v decline, which, recalling utility function (1), implies that welfare must go down.

Half of the intuition for this result is that as capital becomes more liquid, a larger amount of capital is accumulated to serve as a means of payments. If the economy starts from a situation in which the rate of interest on pure bonds exceeds the marginal productivity capital, capital accumulation will result in lower sustainable consumption. The other half of the intuition is that, by assumption, consumption and liquidity are normal goods, and the opportunity cost of liquidity holding in terms of consumption, $r = \delta$, does not change as θ rises. Therefore, the demand for liquidity falls in tandem with consumption, pushing down welfare as measured by expression (1).[19] Notice that since k rises with θ and the demand for liquidity, $m + \theta k$, falls, it follows that the demand for money, m, falls by more than the increase in θk. In words, the development of more sophisticated financial liquidity-enhancing instruments crowds out old-fashioned money (thus, actually, *destroying* liquidity). It is interesting to note that an increase in the liquidity-enhancing parameter θ is welfare-reducing even though,

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[19] The second part of the intuitive argument is essential for the result. To prove it, notice that in a non-monetary economy in which $m = 0$, an increase in θ always gives rise to higher, not lower, welfare.

by assumption, the system fails to achieve the *optimum quantity of money*, i.e., v' > 0 holds – and, hence, more liquidity should be welcome. The explanation is that in an undistorted environment, welfare could increase by lowering the rate of inflation because its marginal cost is zero. The same cannot be said about an increase in θ because it induces an increase in k, which marginal cost is $\delta > 0$, larger than its marginal productivity, $f'(k)$. Incidentally, does it follow that a collapse of θ would be welfare enhancing? The model implies that, if the economy starts from a situation in which $f'(k) < \delta$, there is a case for *orderly* lowering the size and compass of the financial sector. However, it would be a mistake to infer that a fall in θ associated with financial meltdown is welfare enhancing, because the model is too simple and ignores the serious collateral damage associated with those types of crises.

In this example, if $\theta = 0$, the economy will reach a first best in which the marginal productivity of capital equals the rate of interest, $f'(k) = r = \delta$. This situation will not hold under distorting output taxes, poor contract enforcement, etc, that could make $f'(k) > r$. Under those circumstances, an increase in θ could be welfare improving since it could help to offset the market distortion.

4. <u>Endogenizing θ</u>. Liquidity-enhancing parameter θ is a result of individual decisions which are affected by social convention and interaction. The effectiveness of new financial instruments in liquidity creation depends on their acceptability as a means of payments. The latter cannot easily be ensured by individual agents, especially if they are atomistic.

Although a satisfactory model in which θ is endogenously determined exceeds the limits of the present note, one can make some progress by considering the case in which, somewhat unrealistically, individual agents can endow their own land or capital with liquidity properties summarized in parameter θ (ignoring a possible systemic collapse in θ). Think of θ as a brand name that can be attached to land or capital and that makes them more readily accepted as a means of payments. In an open, emerging market economy, for example, the brand name could be provided by some prestigious international financial institution (a fading breed these days!).

Consider the open-economy model in the previous subsection. I will assume that θ carries a consumption cost per unit of pk (i.e., the market value of land or capital in terms of consumption) which is given by function $\varphi(\theta)$, where $\varphi(0) = \varphi'(0) = 0$, and $\varphi''(\theta) > 0$. One can show that, in an interior solution, θ is determined by the following condition

$$\varphi'(\theta) = v'(m + \theta k) = \delta - i_m. \tag{8}$$

Thus, θ rises as i_m falls. As shown in previous subsection, the rise in θ lowers welfare even if $\varphi(\theta)k$ is offset by, say, foreign donors' transfers (and *a fortiori* if it isn't) . This illustrates the possibility – often heard in the debate about the origin of the Subprime crisis – that low interest rates after 2001 induced the development of new financial instruments, like CDOs. In an undistorted situation the development of those financial instruments lowers welfare, even in a scenario in which there no financial meltdown.[20] The unrealistic case studied here makes this result especially interesting, because it does not involve financial market externalities. Parameter θ does not come from heaven (or hell). It is determined by utility-maximizing individuals. The reason why despite their thorough knowledge of the situation these individuals choose a level of θ larger than the social optimum (θ = 0) is that they do not internalize the lump-sum subsidies they will loose as the demand for *m* falls. This is a familiar externality in monetary models, which makes an interesting come-back in the present context.[21] Notice, once again, that the suboptimality of the financial sector holds even though the analysis has completely ignored the costs of financial meltdowns.

IV. Final Words

The simple framework discussed in this note can help to explain some central stylized facts in recent financial crises, including the Subprime and several emerging market crises. The following points illustrate some central implications of the model.

1. The development of new liquid financial instruments linked to the real estate sector may raise *relative* real estate prices. This helps to explain the recent housing boom in advanced economies, and in emerging markets after the creation of the market for Brady bonds and the subsequent development of the Emerging

[20] For the sake of completeness, notice that Friedman's optimal quantity of money is achieved if $i_m = \delta$ or, more generally, $i_m - \pi = 0$. In such a case, θ = 0 which, in an undistorted environment, corresponds to the first-best solution.

[21] The model is a close relative of the one discussed in Ayagari, Braun and Eckstein (1998). In their model, the financial sector endogenously creates a class of goods that requires credit, as opposed to cash in advance. Their model shows, among other things, that higher inflation generates a socially-suboptimal larger range of credit goods. In the present model, inflation is also welfare-reducing in an undistorted environment because it induces capital over-accumulation. I conjecture that introducing i_m in the Ayagari et al model, one should also be able to show that if i_m falls, the range of credit goods expands, lowering welfare – which would be fully in line with the results presented here. I am thankful to Zvi Eckstein for alerting me about the existence of that paper.

Markets bond market (see Calvo (2007)). It also helps to explain a collapse in housing prices as financial engineering turns sour, and gives rise to a "bank run." Under this interpretation, the collapse in housing prices is not necessarily due to the uncovering of faulty or corrupt trades but to the absence of a LOLR that would otherwise help to coordinate the "good" no-bank-run equilibrium.

2. High interest rates can be effective in putting a damper on assets' relative prices, even though all prices (and wages) are perfectly flexible.
3. Preventing deflation may be useful to stave off Irving Fisher's *Debt Deflation*. However, it may not be a solution to the *liquidity/credit* problem generated by the meltdown of real estate *relative* prices, especially if the policy interest rate hits the zero bound, but not exclusively under those conditions. For example, interest rate policy may become ineffective if real assets become illiquid, as it may turn out to be the case under severe financial crisis.
4. Once-and-for-all issuance of helicopter money or Quantitative Easing in the present jargon, without changing the policy interest rate, may prevent price deflation but it is ineffective in changing the relative price of land. However, the relative price of land could be raised if helicopter money generates inflation, provided land is not totally bereft of liquidity.
5. Assets' liquidity enhancement can lead to higher output. Moreover, if initial conditions in the capital market are not first-best, liquidity enhancements could generate Pareto improvement. However, excessive liquidity enhancement that results in lower social welfare cannot be ruled out, even if financial meltdown can be kept in check.

6. An extension that may be worth pursuing is to endogenize financial crises in which liquidity-enhancing parameter θ suffers a sudden collapse, as in the Diamond-Dybvig world of multiple financial equilibria. This could be done, for example, by marrying the present model with the approach discussed in Morris and Shin (1998) to pin down a unique equilibrium solution.

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