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THE LIQUIDITY APPROACH TO BUBBLES, CRISES, JOBLESS RECOVERIES, AND INVOLUNTARY UNEMPLOYMENT

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Abstract. The paper shows that liquidity considerations provide a simple rationale for the creation and destruction of bubbles, and related disturbances in the credit market – the fall in collateral values, in particular. It presents a framework in which credit disturbances can explain jobless recoveries and involuntary unemployment. Jobless recovery follows from the assumption that job creation is at a disadvantage with respect to physical capital investment projects, because the latter furnish their own collateral. Involuntary unemployment arises because, due to severe working capital constraints, the full-employment real wage would ravage work ethic to such an extent that firms find it more profitable setting their wages above the full-employment level – even though nominal wages are perfectly downward flexible. The models are simple and intuitive, and provide an alternative approach which the paper claims is well suited for understanding some basic and common features of financial crises.

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I. Introduction

Future generations will likely remember the turn of the 21st century as the time when mainstream macroeconomics was about to completely remove money and finance from its models, and perished in the attempt. Before the subprime crisis, macroeconomic/monetary theory reached a level of pristine perfection according to which central banks could be masters of the (macro) universe by expertly tweaking a policy interest rate (usually a very short-run interest rate) and/or (some) exchange rate. The hard work was not placed on the shoulders of experienced sleuths that would scour every corner of the financial system in search of structural defects. Rather, the job fell on the shoulders of bright-eyed PhDs whose main task was to develop computer algorithms that would reveal the deep secrets of models in which money and finance were largely emasculated. Money disappeared from the picture as a policy instrument because it was assumed to be an *endogenous* variable. Finance remained but only as a faint shadow of itself; represented by a policy interest rate and a set of inter-temporal arbitrage conditions (which, incidentally, have dubious empirical support). The map was completed by slapping on some exogenous (unexplained and poorly motivated) random shocks and, above all, assuming some kind of expectations' rationality. The latter made the task especially challenging and fit for PhDs in economics (or physics). Don't get me wrong. This is valuable research from a scientific point of view. There is nothing wrong for scientists to explore what may at first look as implausible scenarios (just think of Einstein's theory of relativity!). The problem in this case is that, in my opinion, those models kept central banks from paying enough attention to the workings of the financial system. To be true, central banks were not alone in this struggle. Either inside or outside central banks, there were financial regulators whose countenance better fit that of experienced sleuths. However, financial regulators tended to focus on *micro* issues and, as a general rule, kept their communications with their central banks at a bare minimum (and it seemed to work!).

To be true, for emerging market economies (EMs) the Great Moderation period was much less than tranquil, and it was rather tempting to relabel it Great Immoderation! Sudden Stop crises were the order of the day since the mid 1990s. But this was taken as a reflection of weak domestic institutions involving the financial sector, deficient rule of law and sheer corruption. Get your house in order, was the stern advice from multilateral institutions, and the rest will be fine. As a result, EM crises failed to put a dent on the shining models coming from the *North*. On the contrary, EMs felt the pressure to have their own models, with the same characteristics, if they wanted to have a seat at the table of sophisticated world central bankers. The models' disconnect with EM reality was striking. Central phenomena like Sudden Stops and balance-sheet imbalances (e.g., foreign exchange denominated credit, *Liability Dollarization*) were obliterated (see Calvo (2006)). Fortunately, the higher echelons of several EM central banks were less than completely dazzled by those models – and common sense prevailed. EMs that

had learned the lessons of past financial crises fared relatively well during the subprime crisis. But this was not enough to generate a new macro/monetary paradigm to challenge conventional wisdom.

A prominent characteristic of financial crises is that they seem to come from nowhere and spread like wildfire. Moreover, far from staying within the boundaries of the financial sector, these crises deal a severe blow on the *real* economy: output, expenditure and employment suffer major blows. These characteristics are not easily supported by mainstream macro models in which features like the *permanent income hypothesis* are assumed to prevail, and the financial sector is not at the heart of macroeconomic disturbances. Microeconomics, in turn, was much more alert about liquidity issues. There is a long and distinguished literature focusing on bank runs, for example (see Allen and Gale (2005)). Existence of multiple equilibria is a salient characteristic of those models, a situation that arises because of liquidity considerations. In the seminal paper by Diamond and Dybvig (1983), for instance, banks create liquidity by offering demand deposits, which proceeds are employed to finance long-maturity projects. Depositors are able to withdraw their deposits any time they wish, which is attractive because it helps depositors meet random contingencies. On the other hand, investment in productive projects induces a competitive bank to offer a positive return on those deposits. The resulting risk-sharing arrangement dominates those in a bank-less economy (with incomplete capital markets) and can even help reaching a Pareto Optimum. A major problem is that those banks are subject to bank runs, because if depositors believe that a bank run is in the offing, they will rush to withdraw all of their deposits. Banks would then be unable to fulfill their obligations because part of the funds would have been employed to finance long-term maturity projects. One way to prevent bank runs from happening would be to establish a Lender of Last Resort (LOLR) and other similar arrangements. But the point that I wish to stress here is that the micro-finance literature had a rich arsenal of models which, once again, macroeconomists ignored. A proof of this is that if the bank-run literature had been taken into account, central banks would have realized that "shadow banks" – central factors behind the subprime crisis – were, in principle, bereft of a LOLR, and could easily be toppled by a wave of negative self-fulfilling expectations.

In the present paper I will argue that liquidity can help to rationalize the creation and destruction of “bubbles” in an intuitive manner, and without having to assume that they stem from highly unlikely *real* supply shocks ("tail risks"). To illustrate this, I will employ a model in which liquidity services have a role to play (e.g., facilitating market transactions). But, in contrast with the conventional models in which liquidity is represented by “money” only, I will assume that real goods can also provide liquidity services. This is not a novel assumption. However, it seems to me that the importance of this assumption for understanding the

significance of a liquidity crunch in explaining central features of financial crises has been largely overlooked.

To study the implications of this assumption, I will initially focus on the case in which the only available real asset is inelastically supplied land. This setup is enough to demonstrate that the relative price of land in terms of output increases as land becomes more liquid. Thus, for instance, financial innovation that enhances land's liquidity may help to explain a real estate "bubble." This is not an irrational bubble because it would stem from a *fundamental*, i.e., financial innovation. This effect is altogether missed by mainstream macro because liquidity of real assets is not part of the story; in fact, for someone sticking to the conventional approach, the increase in the price of land would have no explanation in terms of his/her model's smaller set of fundamentals.

Since conventional money is part of the model discussed here, I will be able to test the effects of standard monetary variables. To highlight the role of liquidity, I will conduct the analysis under the assumption that prices and wages are perfectly flexible. I will show that variables like the policy interest rate and the rate of inflation have an impact on the relative price of land that would be absent if land's liquidity was abstracted from. For example, a fall in the policy interest rate boosts land's price; this supports the view that Greenspan's low interest rates after 2001 may have fueled the boom in US real estate prices (see Taylor (2009)). On the other hand, "helicopter money" which increases the supply of, say, high-powered money without touching the policy interest rate has no impact on the relative price of land. Therefore, simply expanding the balance sheet of the central bank may not cushion the economy from the fall in collateral values in terms of output.

The fall in collateral values implied by a liquidity crunch is then employed to argue that a liquidity shock could bring about significantly lower credit flows. This is bound to have negative effects on employment and output, as it drains working capital credit. The fall in collateral values does not affect all projects alike. I will argue that projects involving new labor hires are hard to finance relative to those involving physical capital, because the latter come with their own collateral, whereas the former require posting collateral not directly linked to hiring. This helps to explain so-called jobless recovery. In addition, I will explore a situation in which the credit crunch is so severe that full employment would call for a major collapse in real wages. This may be seriously detrimental to workers' morale to such an extent that firms will find it optimal not to lower wages below a certain critical point, even though unemployed laborers are willing to work for a smaller wage. This type of involuntary unemployment cannot be cured with monetary policy unless substantial credit flows can be unleashed to credit-constrained sectors or labor subsidies are enacted. Open market operations may be highly ineffective in this respect.

Identifying liquidity as an important factor in financial crisis episodes is very different from claiming that liquidity is the missing piece of the puzzle that will henceforth give us a solid foundation for macroeconomic policy. Liquidity is a subtle phenomenon that cannot be measured in terms of, say, "mass" or "energy." An asset's liquidity depends very much on social convention, market makers and the availability of LOLR. This makes liquidity hard to pinpoint and potentially unstable.[2] Liquidity's capacity to rationalize bubbles and sudden crashes derives from its relative inscrutability and surprising dynamics. This has to be faced point blank by macroeconomics. Liquidity will not easily submit to the concavity and continuity assumptions that conventional theory calls for, unless we find a way to tame it without destroying much of the energy of market economies. To stress this point the paper will start in Section II by discussing Liquidity Illusion, and then analyze how its creation and destruction can affect the real economy. Section III will examine the phenomenon of jobless recovery and involuntary unemployment, where both are depicted as stemming from credit-market malfunction. Section IV concludes.

Foundations of the Liquidity Approach

One of the most revolutionary and enduring contributions of the *General Theory* (Keynes (1961)) is the central role given to *liquidity* and *liquidity preference*, a topic later elaborated and expanded by Minsky in an important body of work, which has only recently been widely recognized by the profession (see, e.g., Minsky (2008)). The reader will find some echoes of those books in the present note and conclude, perhaps, that what I offer in Section II is a bare-bones version of some of their ideas (which would be good enough for me!). In my view, however, the main contribution of that part of the paper is that it focuses on liquidity issues, almost exclusively, leaving aside many other financial issues discussed by Keynes and Minsky that, although highly relevant, may make it much more difficult to appreciate the power liquidity considerations have for explaining the mechanics of financial crises. Moreover, while I think the liquidity approach is fundamental for understanding financial crises, I am less sure that it is fundamental for explaining what might be called the *poverty of nations*, as the *General Theory* seems to suggest. [3] Section III, in turn, stands mostly on its own.

II. Liquidity Illusion and Disillusion

The topic of *Money* Illusion has been at the center stage of monetary theory for many long years now (see, e.g., Fisher (1928)). Money illusion is a situation in which a substantial number

[2] For an up-to-date discussion of liquidity issues stressing relevant institutional aspects, see Mehrling (2011).
[3] To wit "That the world after several millennia of steady individual saving, is so poor as it is in accumulated capital-assets, is to be explained, in my opinion, neither by the improvident propensities of mankind, nor even by the destruction of war, but by the high liquidity-premiums formerly attaching to the ownership of land and now attaching to money," Keynes (1961, Chapter 17).

of economic agents miscalculate the *real* (or output) value of nominal flows (e.g., wages) or stocks (e.g., high-powered money). To illustrate, let W denote the nominal wage and P the price level. Therefore, the real wage $w = W/P$. The explicit or implicit assumption in the money-illusion literature is that agents have a much more accurate assessment about W than about P; hence, they are bound to miscalculate w because they base their computations on the wrong price level, which I will denote P^e (e for "expected"). Keynes in the *General Theory*, for example, claims that workers resist a fall in W because they have a relatively fixed notion about P^e. This induces workers to reject lower nominal wages, resulting in high real wages and unemployment during a price-deflation episode. This *expectations stickiness* is still high in policymakers' minds, and it is a major factor in their aversion to price deflation.[4] Another popular example of money illusion that is more akin to the ensuing discussion involves the stock of *money*. Denoting the stock of money in nominal terms by M, I define real monetary balances, m, by $m = M/P$. Again, money illusion in this instance is defined as a situation in which a significant number of economic agents miscalculate m. Thus, assuming expectations stickiness, an increase in M will make some agents feel richer even though the price level rises in the same proportion as M (keeping actual m constant). The seminal rational expectations model in Lucas (1972) portrays this feature. A feature shared by the above examples is that money illusion arises because individuals make mistakes in estimating the *denominator* in the definition of w or m – not the numerator.

Henceforth, I will focus on M. I will consider situations in which individuals know M, but dividing M by P does not necessarily give a correct assessment about *real* monetary balances. An example may help to motivate the discussion. Consider the case in which M is equated to M1, which includes bank deposits, and is typically defined by $M = H + D$, where H stands for high-powered money in the hands of the public (or "cash" for short) and D denotes bank deposits. Under normal conditions, the relative price of D in terms of H is unity. However, this may not hold if, for instance, there is a bank run. Thus, it is possible for individuals to make errors if there is a bank run. But as the bank-run literature illustrates (e.g., Diamond and Dybvig (1983)), a banking system may easily display multiple equilibriums, which means errors – indeed, even "large" errors – could be "rational" because rational individuals may not have the information that allows them to base their judgment on "objective" probabilities. Central banks usually ensure that the relative price of deposits in terms of cash is equal to 1 and, therefore, errors about the relative price of deposits are eliminated. However, the example is relevant because the financial sector has a variety of assets that are not protected by a LOLR, like many of the instruments developed by "shadow banks" prior to the recent crisis, including foreign-exchange denominated bank deposits.

[4] Another factor is Irving Fisher's (1933) *Debt Deflation*, which will be discussed later in this note.

In what follows, I will show the channels through which liquidity illusion can impact asset prices, the credit market and output.

Liquidity and Asset Prices, or How Liquidity Can Create (the Illusion of) Real Wealth

I will illustrate the impact of liquidity on asset prices in terms of a simple model. Again, let us denote real monetary balances by *m*; I will assume that there is another asset, land, which is in fixed supply. Output, *y*, is produced by land, and the production function satisfies $y = \rho k$, where ρ is a positive constant. Real (in terms of output) liquidity is produced by *m* and *k*. Let real liquidity be denoted by *z*. I will assume that *z* satisfies the following central equation:

$$z = m + \theta q k, \tag{1}$$

where *q* is the relative price of land in terms of output, and θ is the liquidity parameter, $0 \leq \theta < 1$. Thus, capital is endowed with liquidity but will not dominate money, unless the return on capital is high enough (because $\theta < 1$). One can think of land liquidity as produced by bank deposits that are channeled to the purchase of land or by Collateralized Debt Obligations, CDOs, with land as collateral.[5]

Let us take *z* as given and look for the combination of *m* and *k* that minimizes the cost of liquidity holding. The opportunity cost of holding liquidity, at steady state, where $\dot{q} = 0$, is given by the following expression:

$$(r + \pi - i_m)m + (rq - \rho)k, \tag{2}$$

where *r*, π, and i_m stand for real interest rate (i.e., output own-rate of interest), inflation and interest rate on money. Here I follow Calvo and Végh (1995) in identifying i_m with the policy interest rate set by the central bank. The optimal combination of non-negative *m* and *k*, given *z*, is obtained by minimizing cost (2) subject to equation (1), $m \geq 0$ and $k \geq 0$. To solve it in a straightforward manner, I will use constraint (1) in equation (2), yielding

$$(r + \pi - i_m)(z - \theta q k) + (rq - \rho)k. \tag{3}$$

Thus, the problem is now equivalent to minimizing expression (3) with respect to land *k*. Expression (3) is linear with respect to *k*. Hence, interior solutions require that the cost of liquidity holding be independent of *k*. A necessary and sufficient condition for this condition to hold is

$$-(r + \pi - i_m)\theta q + rq - \rho = 0. \tag{4}$$

[5] For a discussion on how an expression similar to (1) can be derived in a model with bank loans and deposits, see Calvo (2011b).

Solving for the price of land q from equation (4), we get[6]

$$q = \frac{\rho}{r(1-\theta)+(i_m-\pi)\theta}. \tag{5}$$

To help intuition, consider the special case in which $r = \rho$, and inflation and the interest rate on money are zero (i.e., $\pi = i_m = 0$).[7] Then,

$$q = \frac{1}{1-\theta}. \tag{6}$$

It follows that an increase in land's liquidity raises the price of land in terms of output. Moreover, by equations (1) and (6), it follows that

$$m = z - \frac{\theta}{1-\theta}k. \tag{7}$$

Therefore, an increase in land's liquidity displaces money, given z.[8]

An important insight of the model is that standard fundamentals (ρ in the present case) are not enough to rationalize asset prices. The latter may widely differ from what can be inferred from standard fundamentals, given that $q = 1$ if $\theta = 0$ (recall equation (6) and the assumption $r = \rho$). However, standard fundamentals still play a key role. For example, if land was totally unproductive, i.e., $\rho = 0$, then, by equation (5), $q = 0$. Thus, the present approach does not help to rationalize the existence of *pure* bubbles, unless the underlying assets are perfect substitutes for regular money, m.

Parameter θ will be endogenized below but it is inadvisable to rush to do it. Parameter θ should be thought of as the result of a complex transactions network, which may be highly stable for some periods of time but is subject to sudden revision and, in particular, collapse. Premature endogenizing may give the wrong impression that liquidity is another stable structural parameter, when the whole point of the liquidity approach is that liquidity is not a fundamental based on individual preferences or production functions. This view is portrayed in the seminal paper by Samuelson (1958). This line of research, in which some concept of "liquidity" is exogenous to the model, is an active area of research; see, for example, Farhi and Tirole (2010) and Martin and Ventura (2011).

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[6] Notice that the interior equilibrium price of land q is independent of the inelastically supplied stock of land. This is an implication of the strong linearity assumptions of the model.

[7] For a derivation of equation (5) in a general-equilibrium rational-expectations setup, see Calvo (2011b).

[8] By equation (7), $m = 0$ whenever $\theta \geq {}^{z}/_{k+z}$. Notice that if nominal money stock M is given, an increase in the liquidity of land, i.e., an increase in θ, provokes a rise in the price level P. This effect would not necessarily hold under other sensible modeling of liquidity services in which the marginal substitution between money and land was not constant and depended, for example, on the land/money ratio.

As it stands, the model can also be employed to get some insight on monetary policy and asset prices. By equation (5), a drop in the policy interest rate, i_m, increases the price of land q, *conditional on land exhibiting some liquidity* (i.e., $\theta > 0$). This gives some support to the conjecture that the real estate bubble, in the US at least, may be partly due to the Fed's low rates of interest following 9/11 (see Taylor (2009)). This result is new; it does not hold in standard monetary models, because in those models $\theta = 0$. Likewise, an asset price bubble could be controlled by raising the policy interest rate. One thus wonders, incidentally, if the present regime of exceedingly low interest rates is not provoking liquidity bubbles in a variety of assets, e.g., gold, and real estate in emerging market economies (EMs), for example.

Liquidity Destruction. Shattered Dreams: Asset Price Meltdown and Credit Sudden Stop

As pointed out above, liquidity does not hold in isolation. Robinson Crusoe would have had little use of financial liquidity (unless he was an inveterate miser!). Moreover, another central characteristic of liquidity, as pointed out above, is that it can quickly evaporate. Diamond and Dybvig (1983) provides a nice example in which, without a Lender of Last Resort (LOLR), liquidity could be destroyed in a flash, even though it provides a social service (in their model, liquidity provides some form of insurance). A similar situation occurs in a slightly fleshed-out version of the above model in which land liquidity is a function of expectations. For example, if land is suddenly expected to be devoid of liquidity, then there will be no incentives for holding land for liquidity purposes, and $\theta = 0$. If $\theta > 0$ prior to this liquidity-expectations shock, the price of land will collapse, and analysts are likely to characterize the episode as a bust of the real estate bubble.[9] The consequences of this may be minor if the collapse was widely anticipated. Otherwise, if specifying state contingencies in financial contracts is costly, the price collapse is unlikely to be incorporated in state-contingent contracts. Under those circumstances, leveraged speculators may be subject to margin calls and forced to liquidate other assets in a short span of time, triggering fire sales and a generalized fall in asset prices (except in the unlikely case in which assets being sold are perfectly liquid). The fall in asset prices lowers collateral values and causes a sudden stop in bank credit flows. The latter is more likely, the closer are borrowers to their collateral constraints, which is arguably the case after a credit boom.[10] If prices and wages are flexible and debts are denominated in domestic currency, *real* debt rises (bringing about Irving Fisher's Debt Deflation, see Fisher (1933)) inducing deleverage in indebted sectors. Even setting aside Keynesian aggregate-demand effects due to different marginal propensities to spend between lender and borrowers, the sudden cut in credit flows may bring about a new round of *sharp changes* in relative prices, because the composition of debtors' and creditors' consumption and investment baskets are

[9] For a model with a similar flavor that focuses on capital inflow episodes, see Calvo (2011a).
[10] For recent papers showing that credit booms could be harbingers of financial crisis, see Agosín and Huaita (2010), Schularick and Taylor (2009), and Reinhart and Rogoff (2011).

unlikely to be the same. These changes stem from an unanticipated liquidity crunch. Therefore, it is unlikely that individuals are well prepared to cope, or even understand the nature of the shock. The impact of a credit crunch differs across sectors and individuals. This environment is enormously more complex than a market economy under normal conditions in which the knowledge of a few price series and the reputations of a select number of business partners may suffice. Creditworthiness, in particular, is very hard to assess because the shock raises doubts about every agent in the system, with few exceptions. Opinions depend on individual experiences and, thus, may sharply differ across individuals. This militates against assets' liquidity because salability is hard to assess – exacerbating the collapse of asset prices. In this manner, a liquidity crunch could generate wholesale insolvency problems and Knightian uncertainty (see Frank Knight (1921)). Notice that none of these effects depend on wage/price inflexibility. They stem from the toxic link between liquidity and asset prices, a phenomenon largely ignored by mainstream macroeconomics, including the New Keynesian approach (which, by the way, should more appropriately be labeled *New Hicksian*, for Hicks (1937)).

But, the question arises, if the root of this nightmare is a liquidity shock, why not instruct the central bank to offset the shock by engaging in a massive infusion of central bank liquidity (i.e., a massive increase in money supply)? This is somewhat what the Fed and the ECB have been trying to do. However, as equation (5) shows, a once-and-for-all increase in nominal money supply has *no* effect on *relative* asset prices. Thus, averting cpi deflation has no effect on credit problems stemming from the fall of collateral values. It helps to stave off Debt Deflation, but it may be far from restoring financial health – which, by the way, helps to explain why the world economy is still in the doldrums despite the absence of cpi deflation. The situation might be better if, assuming that debt is denominated in domestic currency, the price level P increased sharply enough so as to keep the nominal price of land (= qP) virtually intact. The implementation of this, however, is fraught with serious problems. Take the case of the US where average real estate prices fell by around 30 percent, and consider the case of many borrowers who borrowed close to 100 percent of their house's market value. To compensate these borrowers, the price level P would have to increase by 30 percent in a short span of time! Given the political circumstances, I much doubt that Bernanke or Trichet would have been able to hold on to their posts if they dared to travel even half-way that route. Besides, by equation (5), the once-and-for-all price-rise shock would not be strong enough to restore assets' relative prices and reinvigorate the rickety credit market. On the other hand, if political resistance can be overcome, high inflation π could be more effective because, by equation (5), it would be capable of lifting the price of land q.[11] But, even this policy would be rendered ineffective if land's liquidity completely collapsed (i.e., $\theta = 0$).

[11] That is what theory implies. However, the present theory abstracts from realistic and important issues having to do with inflationary expectations, which may offset the benefits of higher inflation highlighted here.

In summary, a liquidity meltdown may seriously complicate the workings of the credit market and provoke major changes in relative prices that exacerbate credit-market problems. Averting price deflation may not prevent the generation of a vicious cycle.

A Brief Detour: Modeling Debt

Debt problems are not borne out by conventional closed-economy representative-individual models, because in that setup individuals are identical to each other and are neither net borrowers nor lenders in equilibrium.[12] However, high debt can be rationalized in terms of an open-economy model (opened to trade and capital flows) without having to discard the representative-individual assumption. Debt can be positive or negative in equilibrium, and takes the form of external debt. Suppose, for example, a world with a common currency (e.g., gold), $\pi = i_m = 0$, and that external creditors do not care about the liquidity services provided by land. There is perfect capital mobility but loans to domestic residents will take place if and only if they ensure a real rate of return equal to r, internationally given, and do not exceed a maximum loan-to-equity ratio (in order to ensure incentive-compatibility). Suppose $r = \rho$ and that, initially, land yields no liquidity services for domestic residents. Then, by previous analysis, land's price would be unity and it would offer the same services to foreign and domestic residents. I will assume that, initially, land is fully owned by foreign residents.[13] I will now consider the effect of a financial innovation that succeeds in increasing the liquidity of land for domestic residents only. This obviously makes land more attractive to domestic residents, and at an interior equilibrium (in which $m > 0$) domestic residents will be willing to buy all the foreign residents' land. I will assume that demand for liquidity, z, stays the same.[14] Thus, the price of land q is given by equation (6), implying that $q > 1$. Let m_0 and m_1 stand for the demand for real monetary balances before and after financial innovation, respectively. Therefore,

$$z = m_0 = m_1 + \theta q k = m_1 + \frac{\theta}{1-\theta} k, \tag{8}$$

implying that

$$m_0 - m_1 = \frac{\theta}{1-\theta} k < \frac{1}{1-\theta} k = qk. \tag{9}$$

[12] To be more precise, in that context one can still account for debt obligations between the private and the public sectors. However, that is not an issue that appears to shed light on the link between liquidity and debt, and will be ignored in the present paper.

[13] This assumption helps to streamline the argument presented below and could be replaced by other more realistic assumptions.

[14] At an interior solution the marginal cost of liquidity is invariant to this type of financial innovation, which helps to rationalize a constant demand for liquidity z.

Therefore, the demand for money falls (i.e., $m_1 < m_0$), but freed up resources (i.e., $m_0 - m_1$) are not enough to buy the entire stock of land, *qk*. This is so because, by (9), the difference, i.e.,

$$qk - (m_0 - m_1) = qk - \frac{\theta}{1-\theta}k = k > 0. \quad (10)$$

The difference is borrowed from foreign residents at interest rate *r*. The loan-to-equity ratio is

$$\frac{k}{qk} = 1 - \theta < 1. \quad (11)$$

Thus, if $1 - \theta$ is smaller than the maximum loan-to-equity ratio, borrowing will take place, and it will be enough to buy all of foreign residents' land. This will be reflected in *gross* portfolio capital inflows equivalent to *k* in terms of output (the output equivalent of the external loan to purchase domestic land at price *q*) *plus* $m_0 - m_1$ (i.e., the decumulation of global currency holdings by domestic residents in order to complete the land purchase), coupled with FDI outflows equal to *qk*. By (10), gross inflows and outflows are equal implying, of course, that net capital flows are zero. The operation does no widen the current account deficit. Thus, an observer that ignores the possibility of a liquidity meltdown, would see no reason for concern.

Consider now a liquidity crunch pushing θ down to zero and hence, by expression (11), raising the loan-to-equity ratio. This may force borrowers to liquidate some of their land, in which case the only option would be to sell it to foreign residents. The price of land will fall to 1, implying a capital loss for domestic residents. However, this is likely to be the least of their problems. By assumption, land renders no liquidity services to foreign residents, thus the sudden liquidation of land may entail additional fire-sale type losses, which could be easily modeled in a richer framework. This example captures in very simple way the disruption in capital markets that might ensue from a liquidity meltdown.

Liquidity Creation and Destruction: Dreams and Nightmares

Until now, the discussion has taken liquidity creation and destruction as exogenous processes. This is a good first approximation to understand the basic role of liquidity, but it does not give much insight relevant for understanding the kind of financial innovation and destruction associated with the subprime crisis. Unfortunately, liquidity endogeneity is a hard subject. Mainstream macroeconomics has ignored it, and the available literature addresses fundamental topics but it does not shed light on the issues highlighted above (see, for example, Jones (1976), Kiyotaki and Wright (1989)). The papers are useful for developing intuition about the factors that may play a role in determining an economy's choice of one or several means of payment, including some general welfare implications. But little more than that. Here I will pursue a much more modest approach in which I take the assets which are candidates for being

endowed with liquidity as given, and examine how their liquidity reacts to variables like inflation and the central bank interest rate. Moreover, I will focus on the model developed above and study the determination of the liquidity parameter θ. Following Calvo (2011b) I will assume that individuals could endow their land holdings with liquidity at a cost. This they can do, for example, by offering insurance against low land productivity, or paying a fee to a well-respected firm (Sotheby?) to advertise the land, or making individual plots of land part of a pool administered by a well-known global bank. The latter arrangement would be akin to asset-backed securities which have played a prominent role in the subprime crisis. These are just examples in which individuals may have incentives to make their holdings better known to potential buyers by enhancing their liquidity.[15]

I will assume that the output cost of endowing a piece of land *k* with liquidity is an increasing function of the value of land *qk*, and the liquidity coefficient θ. More concretely, I will assume that the cost function is given by $\varphi(\theta)qk$, where function φ is defined on the nonnegative real line, it is twice-continuously differentiable and $\varphi(0) = 0, \varphi' > 0$, and $\varphi'' > 0$. The assumptions are intuitive and are partly made in order to ensure that second-order conditions can be taken for granted. Under these assumptions, the opportunity cost of holding liquidity would take the following expanded form (recall expression (3)):

$$(r + \pi - i_m)(z - \theta qk) + (rq - \rho)k + \varphi(\theta)qk. \tag{3'}$$

Hence, minimizing (2') with respect to θ, we get the following first-order condition:

$$\varphi'(\theta) = r + \pi - i_m. \tag{12}$$

Correspondingly, assuming an interior solution, equation (5) becomes

$$q = \frac{\rho}{r(1-\theta)+\varphi(\theta)+(i_m-\pi)\theta}. \tag{5'}$$

The price of land is lower than in the exogenous-liquidity model, reflecting the cost of liquidity, but it can readily be shown, employing equation (12), that the effects on *q* of a change in *r*, i_m and π have the same signs as in the basic model in Section II. Thus, new results are entirely encapsulated in equation (12), which implies that monetary policy can have an effect on land's liquidity. This is a conjecture that goes back at least to Minsky (1957). He conjectured that tight monetary policy may be partially offset by the creation of quasi-monies. By equation (12), this holds true in the present model if tighter monetary policy increases the real interest rate *r*, a common assumption in conventional monetary theory. But the opposite holds if, given *r*, central bank tightening operates through a higher i_m. The intuition is that a higher i_m makes

[15] The analysis will be confined to a competitive environment which is likely to be inconsistent with the example of land pooling by large corporations.

money more attractive relative to land and, thus, the payoff of making land more liquid declines.[16] Similarly, an increase in the rate of inflation (from which land is insulated at steady state) makes land more attractive, increasing the payoff of land liquidity. Thus, the model gives further support to the argument that the Fed's lax monetary stance after 2001 is responsible for the real estate bubble (once again, if "lax" is equivalent to low i_m). But the model also provides some backing to the view that the bubble stems from "savings glut" in Asia, which arguably pushed down real interest rates, r.

Liquidity meltdown has received much greater attention in the literature (although, again, mainstream macroeconomics is oblivious about it). For example, to rationalize a liquidity crunch through a collapse in the liquidity coefficient θ, one can appeal to the bank-run literature (e.g., Diamond and Dybvig (1983), Allen and Gale (2005)). The meltdown of "shadow banks" had similar characteristics to an old-fashioned run on bank deposits. In the subprime crisis, the run was staged mostly by bond holders (even in the case of Northern Rock, see Shin (2010)), and the ensuing financial distress was linked to maturity mismatch between assets and liabilities. A full-fledged model would probably include the probability of liquidity crunch into the decision of liquidity creation – a feature that is ignored in the model discussed above – although I doubt that this feature will result in a significant modification of previous insights. However, the analytics are likely to get substantially more complicated. For instance, one would have to specify a mechanism for equilibrium selection (the bank-run model exhibits equilibrium multiplicity). An option is to adapt the model in Morris and Shin (1998). A simpler one is to assume that the probability of liquidity crunch is exogenous. If one has in mind the US and advanced economies, the probability of severe liquidity crunch can realistically be modeled as very small. Thus, as a first approximation, one should not be far from target by assuming that the probability is zero, in which case the model of liquidity creation discussed above stands unchanged. The zero-probability case also serves to illustrate, if not dramatize, the financial disarray that follows a liquidity crunch, because under zero probability no financial contract will take that contingency into account, and bankruptcies will be the order of the day.

In sum, this segment shows that one can get some insights about liquidity creation by assuming that liquidity can be created at a cost. The insights suggests that policies followed after 9/11 may have contributed to enhancing the liquidity of some financial assets, even if one abstracts from regulatory changes. Finally, it appears that from a macro perspective the assumption that liquidity meltdown are exogenous low-probability events may not be misleading.

[16] An increase in i_m increases the demand for m and, in a closed economy model, pushes down the price level. However, if prices are sticky, this may give rise to higher real interest rate r. Therefore, the net effect on the liquidity coefficient is ambiguous unless one makes more explicit assumptions about the demand side.

III. Jobless Recovery and Involuntary Unemployment

A salient feature of recovery from financial crisis is that certain key relative prices like the real wage and the real exchange rate do not bounce back to their pre-crisis levels (see Calvo, Izquierdo and Talvi (2006)). In the US, output has still not reached pre-crisis level but it is already evident that the labor market lags far behind with unemployment still hovering around 10 percent.[17] In this section I will explore two lines of explanation geared to disturbances and imperfection in the labor and credit market.

Collateral Constraints

A liquidity crunch may bring about sharp changes in relative prices and wealth destruction, lowering the output value of assets that can be employed to collateralize – and, thus, support – credit transactions. However, there are various ways in which the economy can start mending itself, even if it gets no external help or the government remains inactive.

To illustrate this point, consider the case in which banks require borrowers to post collateral in order to ensure that they have incentives to repay (a typical principal-agent problem), and that there are three types of investment projects: (1) firing old workers to improve efficiency, (2) buying new computers, and (3) hiring new workers. Firing old workers is the easiest to fund. It requires little imagination. Basically, all you have to know is severance costs and foregone wages (the benefit), and make sure that output stays about the same – no new markets have to be opened or new ideas sold to potential customers. In contrast, projects (2) and (3), to the extent that they are aimed at increasing output or developing new product lines, require convincing the banker that there will be a healthy demand for the new stuff. This may be difficult when recovery is still iffy, as in present circumstances. Funding for hiring new workers is likely to be decisively more difficult than buying new computers – and the reason is that computers provide their *own* collateral, a situation that I will characterize by saying that they exhibit "intrinsic collateral." If the project fails, the bank can repossess the computers, a situation that, of course, does not apply to project (3). Project (3) could thus be said to be relatively more "extrinsic-collateral" intensive – where "extrinsic collateral" stands for collateral which is not imbedded in the investment project. Therefore, *ceteris paribus*, in a collateral-scarce environment, project (2) is likely to dominate project (3), which suggests that, as the economy comes out from liquidity/credit crunch, labor-intensive projects may be discriminated in favor of capital-intensive projects that are more likely to be less dependent on extrinsic collateral.[18] Therefore, until the credit market does not recover its pre-crisis conditions, a salient characteristic of Phoenix Miracles, real wages and employment will lag behind output

[17] For some evidence about US recovery, see Calvo and Loo-Kung (2010).
[18] For recent evidence in this respect, see Wall Street Journal (2011), although collateral considerations are not mentioned in the journal's article.

and, if there is real-wage downward inflexibility (a feature that will be displayed by the next model), unemployment will tend to be high.

Involuntary Unemployment (a non-Keynesian perspective)

Deep financial crisis is a brutal blow to the core of the economic system. In contrast to a regular supply shock (standard in mainstream macro theory), a liquidity/credit crunch destroys channels of information. Under these conditions, production efficiency takes the back seat, and output is dictated by financial constraints. A firm could be highly productive and yet unable to have access to working capital, for example. The firm could have an impeccable credit record but this is not enough to establish creditworthiness during financial crisis. The bank has to make sure that the firm's clients – to whom the firm extends trade credit, for example – will repay their debt obligations. Absent that, the firm in question may not be able to comply with its own debt obligations.

A cut in working capital credit lowers the (effective) demand for labor, independently of labor's marginal productivity. If labor supervision is not an issue, the new equilibrium will lie on the labor supply curve. Thus, the fall in the demand for labor dictated by the credit crunch would likely bring about lower real wages and employment; but not unemployment (i.e., excess supply of workers willing to work at the current wage), unless nominal wages are downward inflexible – a problem that could be easily be dealt with by preventing price deflation and will, thus, be ignored in the ensuing discussion. The following discussion will focus on *structural* problems that cannot be remedied by standard monetary or aggregate-demand fiscal policies.

If labor supervision is an issue, the fall in real wages may make supervision matters harder to handle. Consider the case in which individuals face the option of working in firms owned by others (which I will just refer to as true-firms) or become self-employed, the latter being technologically inferior to the former. Thus, without credit constraints and labor supervision problems, labor would be fully allocated to true-firms. For future reference, I will denote the associated equilibrium real wage by w^*. Existence of supervision problems may change things in a dramatic way. Suppose that workers aim at maximizing income and that, hence, if unsupervised they will sneak out of true-firms and engage in self-employment activities which, to simplify the exposition, I assume require no capital or credit. Clearly, without labor supervision true-firms could not survive.

I will now take a closer look at shirking. I will assume that if a shirker is not caught he gets his wage plus self-employment income. Otherwise, he only gets self-employment income. Therefore, given the probability of being caught, shirking incentives are likely to rise as the gap between wages and self-employment income goes to zero. In the limit case in which the gap between true-firms' wages and self-employment income is nil, a true-firm will have to supervise

everybody all the time because workers suffer no cost if caught shirking.[19] Therefore, it is plausible to assume that below a critical point, effective labor costs may *rise*, not decline, with lower wages. Let us denote the critical real wage by $\underline{w}$. Clearly, if the credit-crunch wage $w^* < \underline{w}$, true-firms' equilibrium wages will be higher than w^*, even though workers will be banging at their doors ready to work for less – and, thus, involuntary unemployment arises.[20]

In this scenario, the equilibrium rate of unemployment depends on true-firms' "wage fund," i.e., funds allotted for the payroll, including working capital credit and own funds – and the critical wage $\underline{w}$. The wage fund is not a constant over time because its effectiveness could be gradually augmented by undistributed earnings and/or by a decline in $\underline{w}$. Firms have incentives to increase the wage fund because at the after-shock equilibrium the marginal productivity of labor exceeds $\underline{w}$. Thus, absent credit expansion, employment may rise over time by the accumulation of true-firms' own funds (although this does not guarantee that unemployment will fall, since employment may be outstripped by labor force). The dynamics of $\underline{w}$ depends on what happens in the self-employment sector and on workers' expectations. After the initial credit shock it is likely that workers' discipline would be quickly lost if wages fall below pre-crisis levels, especially if workers have backward-looking expectations. However, $\underline{w}$ is likely to fall over time as unemployment arises and shows no signs to subside. The fall in $\underline{w}$ is another factor that contributes to attenuating unemployment, but in this case real wages will drop and workers' total income may actually contract, deteriorating income distribution. All in all, the process is likely to occur at a snail's pace, a pace much slower than if the economy was facing a sheer supply shock without credit market complications – validating the observation that recovery from financial crisis is more painful and time consuming than if the financial sector was not part of the problem.

Some Key Implications

- The discussion has identified some central factors that prevent quick recovery from financial crisis, a phenomenon that has been amply documented by Reinhart and Rogoff (2010) and others.
- Unemployment arises even absent nominal rigidities, which are central to New Hicksian models. Therefore, beyond a certain point, lax monetary policy may become ineffective in triggering employment and growth – and result in stagflation.[21]
- In contrast, credit policy may be effective, if it helps to increase the wage fund, for example. This could be accomplished by directed credit and/or *debt haircuts* that allay

[19] This is bad enough but things are likely to be worse: who supervises the supervisors?
[20] There are several models bearing this kind of unemployment, but they focused on less-developed countries in which formal-sector wages are "low." See, for instance, Harris and Todaro (1970), Calvo (1979), and Shapiro and Stiglitz (1984).
[21] Phelps (1994) applies this view for non-crisis situations.

deleveraging from highly indebted sectors. These are heterodox policies that will face strong resistance from established orthodoxy. However, their plausibility follows from the fact that serious obstruction in the credit channel prevents the private sector from doing its job.

IV. Conclusions

A major implication of this discussion is that liquidity creation and destruction can have strong effects on some key relative prices and wreak havoc in the credit market, particularly after an episode of sudden and highly unexpected liquidity crunch. This may sound *déjà vu* for some readers because liquidity-crunch episodes are not unprecedented and are known to cause bankruptcies if there is no LOLR bailing out credit-stressed sectors. However, if momentary dearth of liquidity was all that there was to it, liquidity crunches could be easily dealt with by a timely LOLR who pumped in liquidity in the affected sectors. But, as Section II shows, there may be long-lasting effects that cannot be easily undone by open-market operations of the regular sort. The financial sector does not generate liquidity on the back of US wealth, say, but on the back of a much narrower set of assets like asset-backed securities. The example discussed in Section II shows that this type of liquidity-creation process increases the relative price of the underlying assets. This is indeed highly intuitive but, despite its appeal and simplicity, the insight runs against the mainstream's cherished view that "money is neutral," and that monetary policy is ineffective for changing real variables like relative prices and unemployment in the long run (illustrated by the "vertical Phillips curve" conjecture). Granted, the vertical-Phillips curve view refers to money issued by the sovereign, and not private money of the sort discussed in Section II. But it seems to me quite clear that as long as private money becomes a close substitute to sovereign money, economists are prone to jump to the conclusion that private money can be bundled together with sovereign money and display the same neutrality properties (isn't it common practice to define "money" as an aggregate that includes bank deposits issued by private banks?). Another indication that the neutrality proposition ranks high in economists' minds is that the overwhelming majority of financial commentators refer to the recent meltdown of real estate prices as the bursting of a speculative bubble, stemming from irrational expectations, or prompted by SOEs like Fannie Mae, or stealthy financial moguls – but no reference is given to the liquidity effects highlighted in Section II.[22]

The paper focused on issues relevant for the US in the context of the subprime crisis. However, the insights of this note are applicable to a variety of circumstances. For example, a capital-

[22] Taylor (2009) stands, however, closer to the view offered here, albeit in an indirect way; for he claims that low Fed interest rates after 9/11 are behind the real estate price hike, a statement that is supported by the model in Section II but not by mainstream theory.

inflow episode in EMs. Again, the model of Section II can be employed to conjecture that a surge of capital inflows to a given economy can increase the liquidity of some of that economy's assets. In fact, if the economy is small enough, enhanced liquidity could provoke a real appreciation of the domestic currency (i.e., a fall in the *real exchange rate*, defined as the relative price of tradables with respect to non-tradables). This is a typical phenomenon during these episodes, which gets reverted by a Sudden Stop, usually causing severe problems in the domestic credit market. Ignoring the liquidity effect has led policymakers to attribute currency appreciation to their own good policies (of course), catching them mostly underprepared when hit by Sudden Stop (see Calvo (2007 and 2011a)).

Liquidity is a very slippery concept which, unfortunately, economists have eschewed or over-simplified. Concepts like money and liquidity are much harder to model than a regular consumption good, for example. Their market value depends on a transactions technology that is hard to specify and may undergo large mutations during crisis episodes. But this is no basis for ignoring the issue, because it could lead to wrong and costly policy prescriptions. Liquidity is a *fundamental*, and has to be treated like that. Moreover, it changes relative prices and during its inception is likely to foster credit flows. Therefore, although difficult to pinpoint and define in practice, liquidity fingerprints have some regularity that may help to identify the presence of liquidity cycles. Unfortunately, there are other shocks that mimic the effects of liquidity shocks. For example, technical innovations or terms-of-trade shocks. Telling them apart is momentarily more an "art" than a "science." There are many instances, however, in which there is no clear evidence of competing explanations, in which case liquidity should be the primary suspect.

Would it be possible to prevent liquidity cycles? One strategy would be to shackle the financial sector by some Basle *xxx* agreement that shrinks the sector to a mere bureau of exchange. This may prevent serious blow-outs but credit may vanish unless, going back to the 1950s, the financial sector is mostly run by government. On the other hand, if draconian financial regulation fails, new and even more unstable financial institutions may arise. Therefore, the financial regulatory road has to be trod with a high degree of caution. This does not imply total inaction on the part of government.[23] Given the liquidity fingerprints mentioned above, the central bank would be well-advised to imposing counter-cyclical controls on credit flows or capital inflows, and accumulating international reserves during capital inflow episodes. This will not totally insulate the economy from a liquidity crunch, particularly when the latter stems from external sources, but it may help to attenuate its effects.

The liquidity aspects discussed in this note should make macroeconomists more aware that they navigate waters considerably more risky than they used to think, and that the necessary

[23] See Borio (2011) for a similar view and a fuller discussion of these issues.

tools to prevent and manage crises may involve operations resembling those of a Lender of Last Resort. These operations should therefore be incorporated in central bank monitoring. An effective LOLR should have in its ranks individuals with first-hand knowledge of the credit market and credit-market instruments, and should be able to conduct regular stress tests and fire drills to prevent and deal with extreme situations. The latter, in particular, will likely require tight coordination with other government departments, like the finance ministry and the executive branch – not something that can wait for crisis to happen.

In closing, it is worth pointing out that the analysis of Section III regarding jobless recovery and unemployment stems from credit market disturbances, which may or may not be associated with a liquidity crunch. However, absent a liquidity shock it is hard to rationalize credit crunch, i.e., a sudden and large cut in credit flows. If the market senses that there is overinvestment in the real estate sector, for example, investment will start to fall and the economy will decelerate. Sharp recession, like the one triggered by the Lehman episode, is unlikely to happen. For that to occur, a clear signal will have to come from somewhere, which leads investors and financial intermediaries to stop demanding and offering loans in a coordinated way. Some sort of divine revelation. Keynes identified the phenomenon in a more materialistic fashion as 'animal spirits.' If this holds true, 'animal spirits' should be reflected in a wide variety of human endeavors. The appeal of the liquidity factor, in contrast, is that *its very nature* makes it highly labile, and its destruction can easily be verified – while arguments that appeal to 'animal spirits' without liquidity shocks often refer to sudden contraction of consumption or investment that are triggered by a swift and massive change in expectations about the real economy. However, 'animal spirits' in the form of *herding*, for example, could follow a large shock on relative prices caused by liquidity crunch. Since a liquidity crunch easily escapes the attention and analytical abilities of most economic agents, the latter are bound to attribute the corresponding initial drop in asset prices to the existence of a new "downward trend." This "rational" behavior can contribute to magnifying the effects of the initial liquidity shock, and play a major role in major price-bubble episodes.

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