LIQUIDITY DEFLATION AND LIQUIDITY TRAP UNDER FLEXIBLE PRICES
Some Microfoundations and Implications

Guillermo Calvo[1]
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Abstract. The paper discusses some simple microfoundations for Liquidity Deflation, and shows that it could give rise to liquidity trap conditions under perfectly flexible prices. Unlike in Keynes (1936), this is a *Supply Side Liquidity Trap*, SSLT, which challenges the Pigou effect, e.g., it may not be eliminated by a massive helicopter-type increase in liquid government liabilities or large fall in prices and wages. However, as in standard models, low policy interest rates could help reaching full capacity utilization. More interesting, however, is that heterodox policy like direct price controls, for instance, could work. Moreover, the model shows that under Liquidity Deflation the Optimal Quantity of Money (Friedman 1969, Chapter 1) does not call for achieving liquidity satiation, and it is situated dangerously close to a SSLT.

I. INTRODUCTION

Several recent papers suggest that shortage of very liquid (also called *safe*) assets could be a central explanatory factor for the deep and long-lasting Great Recession that followed the Lehman crisis. This is traced back to the massive destruction of safe assets associated with the Lehman crisis (see Calvo 2012, Caballero, Farhi and Gourinchas 2016 and 2017), large demand for and insufficient creation of safe assets due to constraints like the Zero Lower Bound on policy interest rates, ZLB, and sterilized intervention. The ZLB is hard to bypass because it involves thorny operational problems but, in principle, unsterilized intervention, like *helicopter money*, should be less problematic. Therefore, part of the difficulty could be found in central banks' reluctance to utilize unsterilized intervention, particularly in a situation in which long-term Treasury bonds appear to be highly substitutable by Treasury bills and bank reserves — and, therefore, sterilized intervention, like Operation Twist in the US, might be ineffective in relieving safe-asset shortage. But the effectiveness of helicopter money is not free from critics. Keynes (1936), for instance, raised some doubts about the effectiveness of unsterilized intervention by conjecturing that there exists a positive nominal interest rate at which the demand for money becomes infinitely elastic — a situation labeled *Liquidity Trap*. However, Keynes's conjecture is hard to justify in conventional models since, given the price level, helicopter money could increase real wealth without bound and, if there is no consumption satiation, utility maximization should lead to a rise in aggregate demand that matches full capacity output (as implied by the Pigou effect). This criticism to Keynes's conjecture, though, is due to an assumption that is taken for

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granted in conventional macro models, namely, that the liquidity services provided by money are proportional to the stock of real monetary balances. This assumption sounds reasonable in normal circumstances, away from Liquidity-Trap type episodes, but it may be questionable when, as in the Great Recession, the velocity of circulation of monetary aggregates (e.g., M1 and M2) in the US, has fallen to levels not seen in more than half a century.[2]

In recent work I have explored the possibility of a disconnect between *real safe assets* (i.e., the nominal supply of safe assets *divided* by the price level), and their liquidity or transaction services — and argued that beyond a certain point an increase in real safe assets may fail to increase total liquidity in the same proportion. I labeled this phenomenon *Liquidity Deflation*. As shown in Calvo (2016 a and b) and discussed below, Liquidity Deflation helps to validate Keynes's conjecture even though expansion of monetary aggregates is triggered by helicopter money, and the interest elasticity of the demand for money is bounded.

The ideas behind Liquidity Deflation are straightforward, but I have encountered some intellectual resistance in considering its relevance. Part of the reason for this is that in macroeconomics the concept of "money" is associated with an object which liquidity is tarnished by nothing except "inflation". In particular, increasing the supply of "reserve assets," (i.e., assets employed by central banks as international reserves, like US Treasury obligations) is rarely associated in models with a loss of their "liquidity" or transaction services. Thus, I believe that time is high for discussing the *microfoundations* of Liquidity Deflation and, on that basis, get new insights on macro policy around Liquidity Trap episodes. These are the central issues tackled in the present paper.

To motivate the discussion, I will first briefly present in plain English two related Liquidity Deflation scenarios. Then I will spell out a formal model, which will allow us to discuss the mechanics of Liquidity Deflation in greater detail and show, under conventional assumptions, that Liquidity Deflation could completely crowd out the liquidity-enhancing impact of an increase in money supply. Moreover, the model shows that operating near the complete-crowd-out equilibrium is also problematic. Under those conditions, even a slow-paced return to normality may bring about a sharp and unwelcome increase in the price level.

As a bonus, and to insert Liquidity Deflation at the core of received monetary theory, I examine the Optimal Quantity of Money, OQM, issue originally raised in Friedman (1969, Chapter 1). I show that, unlike Friedman's OQM, Liquidity Deflation does not call for reaching liquidity satiation and that the new OQM is located dangerously close to the new Liquidity Trap concept developed in this paper.

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[2] In this paper I will indistinguishably speak of safe, highly liquid assets and money. The focus is on assets that are essential for trade and financial transactions, including assets that are employed for credit collateral. Their composition is not central for the present discussion, and will be ignored.

In the closing remarks I present a short and tentative extension of these ideas to Emerging Market economies, EMs, in which domestic assets could hardly be classified as *safe*. Arguably, however, the search for yield triggered by low-interest-rate of safe assets may have turned some EM assets *safer* (perhaps due to higher turnover), helping to explain the noticeable recent downward trend in EM inflation.

II. LIQUIDITY DEFLATION

a. Intuitive Scenarios

1) Consider an atomistic economy in which carrying cash to the mall saves shopping time (see Végh 1989). However, time saved declines as cash held by the *other* mall customers goes up: a congestion effect. Therefore, from the point of view of each atomistic agent, the time-saving impact of cash holdings increases less than in proportion to cash held: Liquidity Deflation.

2) Alternatively, and more in line with popular narratives of the Great Recession (see Gorton 2010), consider the case in which a highly liquid asset (e.g., US Treasury bond) is used as credit collateral. The collateral value of those bonds depends on the amount of goods and services that the US government could seize by, say, raising emergency taxes. Therefore, if the latter has an upper bound, the value of Treasury bonds *as collateral* may increase less than in proportion to the increase in the (real) market value of Treasury bonds: another example of Liquidity Deflation.

Remark I. The above examples assume that liquid government liabilities are safe. However, this assumption is highly debatable for economies, like Japan and the US, that exhibit large fiscal deficits and debt-to-GDP ratios (especially, if unfunded social security benefits are taken into account). Keynes (1936) offers an alternative explanation, which I labeled the *Price Theory of Money*, PTM, in Calvo (2016 b).[3] The conjecture is based on the observation that sticky prices provide an unintended output backing to money, even if the public sector offers none. I find the PTM more appealing than explanations that rely on the ability or predisposition of the public sector to provide a backstop to money supply in terms of goods and services. Furthermore, if real monetary balances are 'small' relative to the value of transactions subject to sticky prices, the PTM may ensure that money offers safe liquidity, e.g., free from 'runs.'[4] However, safety may deteriorate as the stock of real

[3] To quote the master (emphasis mine): "[...] the fact that contracts are fixed, and wages are usually somewhat stable in terms of money, *unquestionably plays a large part* in attracting to money so high a liquidity-premium" Keynes 1936, Chapter 17.
[4] This helps to explain why currencies that are employed for invoicing and units of account across world economy, like the US dollar, become stronger in terms of output during a Liquidity Crunch episode.

monetary balances becomes large, for the simple reason that, realistically, the flow of real transactions subject to sticky prices has an upper bound.

b. <u>Parsimonious Microfounded Flexible Prices Model</u>

Suppose a standard infinite-horizon open-economy model in which instant utility index satisfies:

$$u(c) - l, \tag{1}$$

where c stands for consumption, u is twice-continuously differentiable over the positive real line, $u' > 0, u'' < 0$, and l is labor required to consume c, e.g., shopping time (see Végh1989). I assume that shopping time increases with consumption and declines with the holdings of real monetary balances. The latter provide transactions services and thus save on shopping time. However, the effectiveness of money to provide those services *declines* as *market holdings of real monetary balances increase*, in line with the above examples. In example II.a.1 the effect can be interpreted as "congestion," while in example II.a.2 it can be interpreted as a decline in money's collateral value.[5]

I assume that

$$l = c - V\big(m + Z(m^e)\big), \;\; V' > 0, V'' < 0, Z' < 0, Z'' \leq 0, \tag{2}$$

where V and Z are, respectively, the timesaving and Liquidity Deflation functions; both are twice-continuously differentiable over the positive real line, and m and m^e are, respectively, the representative individual's holding of real monetary balances and market equilibrium real monetary balances (individuals are atomistic and total population is normalized to 1). Thus, in equilibrium, $m = m^e$. Individuals can single-handedly determine m, but, since they are atomistic, are constrained to take m^e as given.

For simplicity, I will assume an open economy, rational expectations (= perfect foresight because there is no uncertainty), no trade barriers and perfect capital mobility. The representative individual has a constant endowment, y, of (perishable) exportables that are not consumed at home. On the other hand, consumption c is entirely composed of (perishable) importables. The relative international price between importables and exportables is constant and equal to

[5] It is worth noting that, strictly speaking, the Price Theory of Money does not apply if prices are perfectly flexible. However, I assume price flexibility here to show that, granted Liquidity Deflation, price stickiness is not indispensable for existence of Liquidity Trap. Extensions to sticky prices are straightforward, but, at this juncture, would cloud the analysis with superfluous details. For an attempt in that direction, see Calvo (2018).

unity. Moreover, the international real interest rate is *positive*, equals the representative individual's subjective rate of discount, ρ, and (importantly for our discussion here) *exchange rate and prices are perfectly flexible*. Thus, the budget constraint of the representative individual in terms of tradable goods satisfies:

$$\int_0^\infty [y + s_t - c_t - i_t m_t] e^{-\rho t} dt \geq 0, \tag{3}$$

where, without loss of generality, initial wealth is set equal to zero, and i and s stand, respectively, for the market instantaneous nominal interest rate and government's lump-sum subsidies to rebate seigniorage from money creation. We abstract from other government activities and, therefore, assume that other taxes and expenditures are set equal to zero. The government sets nominal money supply at each moment of time.[6]

Plugging equation (2) into equation (1), maximizing utility (= $\int_0^\infty [u(c_t) - l_t] e^{-\rho t} dt]$) with respect to c and m subject to budget constraint (3), and focusing on interior solutions, i.e., $c > 0, l > 0$, we get:

$$u'(c_t) - 1 = \lambda, \tag{4}$$

and

$$V'\big(m_t + Z(m_t^e)\big) = \lambda i_t, \tag{5}$$

where λ stands for the Lagrange multiplier, which is constant over time and determined by equality between present discounted value of endowment and consumption. All of these assumptions are standard in monetary models aimed at highlighting fundamental monetary phenomena — in the present case *Liquidity Deflation*.

To rule out consumption satiation, I will assume $u'(y) > 1$. Thus, by (4) and (5), we get equilibrium consumption $c = y$, and (dropping time sub-indexes):

$$\frac{V'\big(m + Z(m^e)\big)}{u'(y) - 1} = i, \tag{6}$$

Thus, by equation (6), and recalling that $V' > 0$, there exists a function $L(i, y)$, such that

[6] As is well known (Olivera 1970, Sargent and Wallace 1975), when prices are perfectly flexible and fiscal constraints are not binding, as in the present model, setting i does not anchor the price level. However, below I will extend the model to the case of interest-bearing "money," where the latter could be identified with the policy interest rate, as in Calvo and Végh (1995).

$$m = L(i, y) - Z(m^e),\ \ L_i < 0, L_y > 0, \tag{7}$$

Equation (7) is a familiar expression for equilibrium in the money market, except for the term $Z(m^e)$. Clearly, by (7), recalling that $Z' < 0$, the demand for money increases with the equilibrium real stock of money, a conventional "network" effect (see, e.g., Uribe 1987). Thus, although the Z function is here associated with a novel form of externality (i.e., liquidity deflation), the effects would be similar if Z is interpreted as a more familiar network externality.

At equilibrium in the money market we have $m = m^e$, implying, by (7),

$$m + Z(m) = L(i, y),\ \ L_i < 0, L_y > 0. \tag{8}$$

Therefore, recalling expression (2), transactions services, i.e., $m + Z(m)$, may increase with real monetary balances despite the Liquidity Deflation effect, but the model does not preclude the possibility that, beyond a certain point, transactions services *decline*. Condition (8) is depicted in Figure 1, where m^* is assumed to maximize $m + Z(m)$ with respect to m (hence $Z'(m^*) = -1$). The slope of the equilibrium transaction-services equilibrium condition is downward sloping with respect to the nominal interest rate to the left of m^*, as in conventional models that ignore the Z component. However, the slope becomes positive to the right of m^*. Notice that m^* is associated with i^* in Figure 1. Moreover, if $i > i^*$, there may be two values of real monetary balances that are consistent with full equilibrium. This is illustrated in Figure 1 by $i = i'$, at which point the equilibrium real monetary balances can settle at $m1$ or $m2$. Thus, given nominal money supply, the price level may be undetermined. Moreover, I will show in Appendix A that there exists a continuum of equilibrium paths converging to $m2$, even if the rate of expansion of money supply is constrained to be constant over time.[7] This shows that Liquidity Deflation can bring about equilibrium indeterminacy, a major complication for the design of monetary policy. Despite this, however, full capacity utilization is still reachable. However, I will show next that full capacity utilization may not be reachable if $i < i^*$, due to the existence of a new type of Liquidity Trap.

Consider the case in which the nominal interest rate equals $i'' < i^*$ (see Figure 1). By equation (8) and Figure 1, $m^* + Z(m^*) < L(i'', y)$. Hence, i'' is incompatible with general equilibrium. If full capacity utilization holds, i.e., $c = y$, for instance, the money market would exhibit excess demand, a situation that is not resolved by a fall in the price level or increase in money supply (given $i = i''$), because Liquidity Deflation prevents the relevant liquidity concept from rising. Thus, if for some reason i is stuck at i'', the economy would display characteristics akin to a Keynesian Liquidity Trap, except that the latter would be generated by *liquidity supply*

[7] The math involved here is very similar to that in the Optimum Seigniorage problem.

phenomena. I will correspondingly call it Supply Side Liquidity Trap, SSLT.[8] Next I will discuss situations in which it may be difficult for the economy to get rid of SSLT, and even cases in which equilibrium displays some kind of capacity underutilization.

Prior to the Great Recession, a dominant view was that deflation and Liquidity Trap problems could be cured by increasing money supply and raising inflation expectations in a credible manner (see, e.g., Krugman 1998). In the present model this would correspond to being able to raising the nominal interest rate such that $i \geq i^*$. True, Liquidity Deflation can still cause equilibrium multiplicity but, as noted, full capacity utilization is not beyond reach. How to get there? By equation (6), in steady state equilibrium we have $i = \rho + \mu$. Hence, all it takes to move the economy out of SSLT is to set μ such that $\rho + \mu \geq i^*$. In words, all it takes is high enough inflation expectations, which could be achieved by jacking up the rate of expansion of money supply in a credible manner (as proposed in Krugman 1998). Unfortunately, as I argue next, Liquidity Deflation could make the Krugman proposal hard to accomplish.

To simplify the discussion, consider the case in which $m + L(m) = m^* + Z(m^*)$, for all $m \geq m^*$.[9] This situation is depicted in Figure 2, where the solid curve is now flat for all $m \geq m^*$, and $m2$-type equilibrium is ruled out (see graphical proof in Appendix B). Notice that the solid curve looks like the typical textbook Keynesian Liquidity Trap, which, after a critical point (m^* in the present case), becomes infinitely elastic with respect to the interest rate. Suppose that the increase in μ fails to change inflation expectations. Hence, given rationality, at steady state the representative individual should expect inflation to be constant over time, and such that $\pi = i'' - \rho$. Thus, if $\mu > i'' - \rho$, then m will increase without bound, but it would fail to change the relevant liquidity concept (which will remain constant at $m^* + Z(m^*)$). Excess demand for money would continue to prevail, a situation that may plausibly lead agents to expect that, if anything, inflation will fall, making money more attractive — a situation that would look as if a Liquidity Deflation "black hole" is swallowing the entire expansion of money supply!

I will show next that by modifying the equilibrium concept in a simple but not implausible manner, the model could exhibit capacity underutilization or inefficient allocation of resources, without violating transversality conditions and, thus, qualifying as a rational expectations equilibrium. I will assume that under SSLT and excess money demand, individuals divert their attention to finding/developing alternative liquid assets (e.g., crypto-currencies, searching for yield, etc.) in detriment of their endowments, y. Moreover, these negative effects on output do not stop until effective endowment shrinks and restores equilibrium in the money

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[8] See Figure 1, where the set of non-negative interest rates associated with SSLT are indicated.

[9] This holds if $Z'(m) = -1$, for all $m \geq m^*$.

market.[10] Thus, if the economy is stuck at $i = i^{"}$, the equilibrium effective endowment, denoted by y', must satisfy:

$$m + Z(m) = L(i", y'). \tag{9}$$

Clearly, $y' < y$ and $m \leq m^*$. The higher is m, the higher will be y'. Consider the case, depicted in Figure 2, in which $m = m^*$ and, therefore, y' attains its maximum value subject to $i = i^{"}$ (but still $y' < y$).[11] This excess capacity equilibrium is not affected by changes in μ. To be sure, if $\mu > \pi$, m will grow without bound but, as pointed out before, this does not violate any transversality condition because the stock of relevant liquidity will remain constant at $m^* + Z(m^*)$. Since output stays constant and m increases without bound, velocity falls over time.[12] This is in line with what happened during the Great Recession, as the velocity of circulation exhibited a steep decline in reserve-currency economies. Admittedly, the present model is still quite unsophisticated and should greatly benefit from plausible dynamic extensions, but I would be surprised if its central results could be easily overturned.[13]

Remark II. It is worth keeping in mind that if the rate of expansion of money supply, μ, is high enough, there exists a full capacity utilization equilibrium. Thus, recalling Figure 1, it would be correct to say in this context that full capacity utilization could be achieved by *credibly* manipulating money supply so that (in steady state) $i \geq i^*$. However, the discussion also revealed that if, for some reason, the economy is stuck at $i < i^*$, it may not be possible to achieve full capacity utilization by large infusions of money supply, if the representative individual expects low inflation consistent with $i < i^*$. In that situation, there will be excess demand for money combined with excess supply of full capacity utilization output, y — which the model assumes will lead agents to divert their attention to unproductive activities aimed at increasing the supply of liquid assets. This is a very interesting implication of the model, because it offers a new rationale for why it might be hard to have agents believe that inflation will be high enough and generate full capacity utilization. Krugman (1998) made important strides in that direction by claiming that the problem in Japan was that, for some reason, the government

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[10] This is akin to demand-determined output assumption in Keynesian models, although *supply factors* are at work!

[11] In the standard IS/LM apparatus, the adjustment mechanism is parallel to the one outlined above, but relying on sticky prices and demand-determined output. See Calvo (2018) for an analysis of Liquidity Deflation in terms of a New Keynesian model with those characteristics.

[12] It is worth noting that the same type of SSLT equilibrium would hold if the curve in Figure 1 becomes flat at some $m > m^*$ or, in other words, if there exists some $m = m^{**} > m^*$, such that the liquidity of m, i.e., $m + Z(m)$, becomes constant for all $m > m^{**}$.

[13] For a New Keynesian Macroeconomics model in which Liquidity Deflation brings about a fall in the velocity of circulation, see Calvo (2018).

was perceived by agents as being strongly inflation averse, which conspired against credibility and hence effectiveness of an inflationary strategy. The present model offers another reason: if agents' inflation expectations are "too low," the central bank will be unable to jack up inflation because the economy will be stuck at a SSLT where monetary policy is ineffective. It is not the government's inflation aversion that is at stake here, it is the excessively low inflation expectations of the representative individual — expectations that turn out to be rational — giving rise to excess supply of full capacity output and an insatiable demand for liquidity!

However, recalling Figure 1, the model implies that full capacity utilization could be reached if the government couples monetary policy with regulations and arrangements that ensure that inflation is such that $i = \rho + \pi > i^*$ or, equivalently, that $\pi > i^* - \rho$. This involves heterodox procedures that many policymakers try, quite understandably, to avoid. But when all the orthodox procedures have failed, price guidance looks increasingly attractive. Besides, controlling just a handful of prices, e.g., those of public sector services and some large private enterprises, may be enough. This has been common practice in economies facing the opposite problem: stopping chronic inflation.[14] ■

Remark III. SSLT shows the possibility of persistent excess demand for liquidity at full capacity utilization, which in the present model induces unproductive search for alternative forms of liquidity. I suspect that here rests a wealth of new insights that could be found by, on one end, studying empirically plausible endogenous mechanisms of private-sector liquidity creation — and, on the other end, modeling realistic policymakers' response functions in Liquidity Trap crisis episodes. As to the latter, it is not unusual for policymakers to "fight the last war," and take measures (i.e., reaction functions) that are counterproductive in the short run. The Great Recession, for instance, has induced tighter banking and financial regulations that some observers see as having exacerbated liquidity shortage. Moreover, the very existence of rational expectations SSLT equilibrium may lead the central bank to prematurely stop pursuing QE and debilitating the effectiveness of QE if resumed.[15] ■

I guess that Keynes would have been pleased by these results. He spent much of Chapter 19 of his *General Theory* discussing several instances in which even downward flexible wages would fail to achieve full capacity utilization. However, he utilizes arguments that are absent in the previous sections of the book. This is unfortunate because the lack of foundations leaves this important conjecture hanging in the air. It is probably the reason why post-Keynesian models rely exclusively on price stickiness assumptions. In contrast, Liquidity Deflation is a

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[14] See Bruno et al 1991.

[15] Recently, the ECB and the BOJ appear to have given up fighting deflation by means aggressive QE and switched instead to low interest rates. Opinion in the financial press was unanimous in concluding that QE had run out of steam, an additional factor militating against the effectiveness of QE.

natural corollary to the Price Theory of Money put forward in Chapter 17 (recall footnote 3, and Remark I).

Although, as pointed out in footnote 6, interest targeting results in price level indetermination, the model could be extended to the case in which the central bank pays interest on m, and m is identified with an aggregate of highly liquid assets. Denote the interest rate on m by i^m.[16] It is easy to show that the money-market equilibrium condition (7) would become:

$$m + Z(m) = L(i - i^m, y), \;\; L_{i-i^m} < 0, L_y > 0. \tag{10}$$

Clearly, lowering i^m reduces the demand for liquidity services and pushes the economy towards full capacity utilization. However, this policy may not be feasible or give rise to problems of its own. For instance, $i^m < 0$ may lead to devising crypto-currencies without an effective Lender of Last Resort that eventually generate severe liquidity crises.[17]

<u>The Optimal Quantity of Money: A Digression</u>. Friedman (1969) shows that abstracting from tax distortions, and assuming that the marginal nominal cost of issuing non-interest-bearing money is nil, the optimum quantity of money — i.e., real monetary balances that maximize social welfare — must be such that the opportunity cost of holding money, i.e., the market nominal interest rate, is equal to zero, i.e., $i = 0$ in the above notation. I will show that this does not necessarily holds under Liquidity Deflation (or network externality).

I will focus on steady state. By equations (1) and (2), the social planner maximizes:

$$u(c) - c + V(m + Z(m)) \tag{11}$$

with respect to $c \le y$, and $m \ge 0$. Since $u'(y) > 1$, optimal consumption $c = y$. The first-order condition with respect to m satisfies:

$$V'\big(m + Z(m)\big)[1 + Z'(m)]] = 0. \tag{12}$$

In absence of Liquidity Deflation, the OQM requires money satiation, i.e., $V' = 0$, which holds, recalling equation (6), if $i = 0$. This is Friedman's result.[18] Notice that

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[16] For a related model, see Calvo and Végh (1995). Variable i^m could also be interpreted as central bank's interest on bank reserves.
[17] It is worth noting that a negative i^m is equivalent to an inflation tax. The latter has fostered Currency Substitution, particularly in economies suffering from Chronic Inflation.
[18] It is worth noting that Friedman's result is not well defined under the assumption in equation (2) that rules out liquidity satiation.

since at steady state $i = \rho + \pi$, in this static model the OQM calls for deflation. More precisely, $\pi = -\rho$.

Consider now the case in which Liquidity Deflation holds. Thus, since by expression (2), $V' > 0$ everywhere, it follows that the OQM calls for setting $1 + Z'(m) = 0$, which, recalling Figure 1, holds at $m = m^*$. Thus, by equation (6), decentralizing the OQM calls for setting the nominal interest rate such that (recalling Figure 1) $i = i^*$, where

$$\frac{V'(m^* + Z(m^*))}{u'(y) - 1} = i^* = \rho + \pi > 0. \tag{13}$$

Hence, if $i^* \geq \rho$, the OQM would call for inflation, not deflation as in Friedman's OQM. Moreover, if money yields a rate of return i^m, equation (13) becomes:

$$\frac{V'(m^* + Z(m^*))}{u'(y) - 1} = i^* = i - i^m = \rho + \pi - i^m, \tag{14}$$

implying that the OQM is achieved if

$$\pi = i^* - \rho + i^m. \tag{15}$$

Thus, the inflation rate is free to take any value as long as it satisfies equation (15).

However, as pointed out above, starting from a SSLT may make it hard for the central bank to implement the OQM. Besides, the OQM $m = m^*$ seats at the borderline to the SSLT region (see Fig. 1), too close for comfort! ■

Thus far, our discussion has focused on the limit case in which Liquidity Deflation completely emasculates the impact of QE (Quantitative Easing). However, Liquidity Deflation problems may still be relevant near the limit, where QE is still capable of increasing liquidity supply. For the sake of concreteness, let us go back to the case of non-interest-bearing m and rewrite equation (7) as

$$m + \beta Z(m) = L(i, y), \;\; \beta \geq 0, \tag{16}$$

and consider the effect of a slight drop in parameter β. If $Z(m) < 0$, the latter amounts to lowering the drag implied by Liquidity Deflation, and can be interpreted as a shift towards "normality." Since, by assumption, QE still works, being near the point where QE would be ineffective, implies that the derivative of $m + \beta Z(m)$ with respect to m is positive but ≈ 0. Hence, recalling that $Z(m) < 0$, one can easily show that a fall in parameter β implies a "large" contraction in equilibrium real monetary balances m. Thus, for instance, if nominal money supply were exogenous, a fall in parameter β would bring about a "large" increase in the price level, given $i - i^m$ and output, which may bring about a sudden unwelcome surge of inflation.

III. CLOSING REMARKS

Having reached this point, the reader may feel that, if one is ready to assume Liquidity Deflation, the above results are trivial (in the pejorative sense of the word). I beg to disagree. Results are indeed trivial — as it happens in any logically consistent theory — but important. Firstly, because Liquidity Deflation unveils a new type of Liquidity Trap (SSLT) from which it is much harder to escape compared to the textbook case, and helps to rationalize some of the key problems faced by policymakers in the recovery from the Great Recession. Secondly, because it brings up to the surface results that clash with the pre-crisis conventional wisdom. For instance, if you ask your "representative" economist (especially prior the Great Recession): "What happens if money supply displays a large increase in a short period of time?" the answer will likely be something like "prices will take a big jump." In symbols, a big increase in M will result in a big increase in P. In contrast, the above discussion focuses on the possibility that a big increase in M will provoke a big fall in the "quality" of M — here identified as a big fall in the "liquidity of M." Thus, in a situation like that, a marginal increase in M may have no effect on P or in the "real value of M/P, adjusted for liquidity services." Thirdly, because Liquidity Deflation — a simple add-on to standard models — might help to develop a "New Synthesis" from which more realistic and complex models will grow (see Calvo 2018). In turn, the opposite strategy, i.e., developing models with a variety of idiosyncratic shocks and assumptions, may actually leave macro theory in limbo, unable to reach professional consensus, and thus making it of little use for policymaking.

The SSLT phenomenon is especially relevant for reserve currencies in economies that have undergone a *severe bout* of Liquidity Crunch. Until 2008, this was not the case for EMs because Liquidity Crunch of EM assets, drove agents away from domestically denominated assets — a kind of Anti-Liquidity Trap — causing a sharp spike in exchange rates and triggering high inflation (see Calvo 2018 b). The reason for this is that a deterioration of EM assets' liquidity did not have a negative impact on the liquidity of global safe assets. This incentivized portfolio shift against EM assets. However, this started to change with the Lehman crisis and ensuing long period of low interest rates in Advanced Market economies, AMs. A 'search for yield' followed, increasing turnover of EM assets, conceivably transforming them in closer substitutes for AM safe assets. As a result, monetary conditions in some EMs started to look like those in AMs. Israel is an interesting case in point. In the 1980s Israel was struggling to get rid of chronic inflation, occasionally reaching staggering levels (e.g., over 350 percent in 1985). At present, however, Israel is facing the opposite problem: *deflation*! Inflation is below the central banks' inflation target by a wide margin, and is perilously teetering around zero. This could, of course, be due to prudent fiscal and monetary policy. But even so, the external conditions may have contributed to increasing the liquidity of Israel liabilities, putting downward pressure on inflation rates, possibly throwing the economy into a SSLT.

In closing, it is worth reiterating that the SSLT phenomenon is associated with situations in which it is hard for policymakers to increase the stock of liquid assets to levels compatible with full capacity utilization. The phenomenon is likely to lose its relevance as economies recover and find new Safe Assets. In capitalist economies this is likely to occur by the hand of the private sector. Once 'normality' is recovered, the old ghost of inflation is likely to revive, and take our attention away from Liquidity Trap, as it happened after the 1930s. This could be a serious mistake if the genie is out of the bottle and the financial sector continues generating new forms of global liquid assets, not protected by a Lender of Last Resort. Thus, to keep these issues in focus, my humble proposal is that textbooks should add the Liquidity Deflation phenomenon on their favorite models.[19]

[19] Notice that Figure B1 in Appendix B makes the SSLT easy to incorporate in an IS-LM model.

Figure 1. Liquidity Market (Dis) Equilibrium

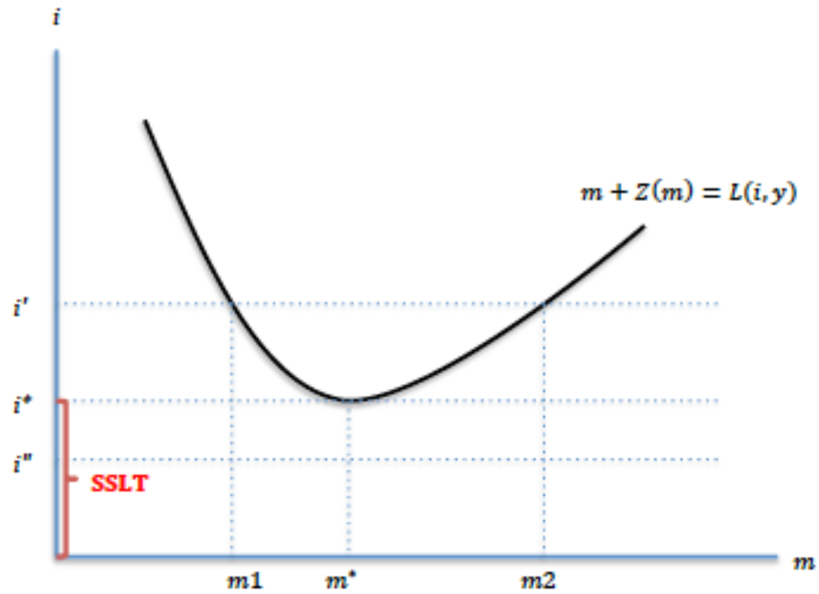
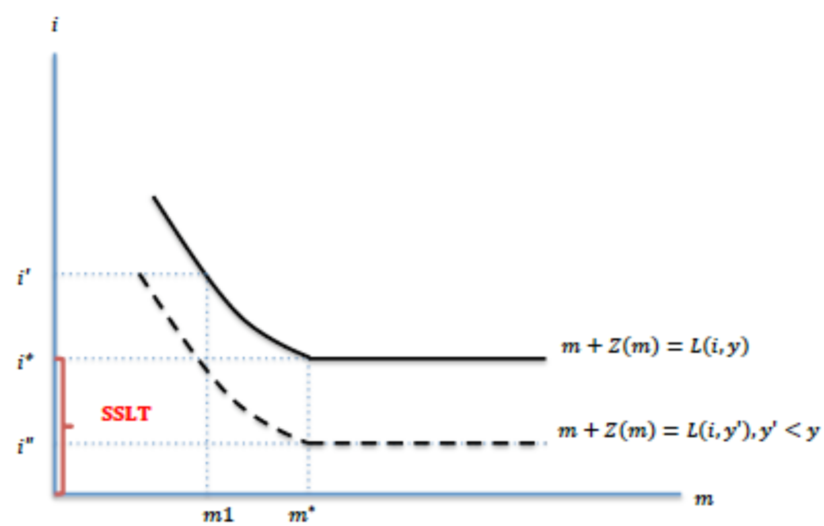


Figure 2. Supply-Side-Liquidity-Trap Equilibrium



Appendix A

The analysis in the main text focused on steady-state equilibria. I will sketch out an extension to the general case, but ruling out explosive equilibrium solutions. I will constrain the attention to non-interest-bearing money.

Dropping time subindexes, and recalling that nominal money stock is assumed to grow at a constant rate μ, we have

$$\frac{\dot{m}}{m} = \mu - \pi. \tag{A1}$$

Moreover, since this is an economy subject to perfect capital mobility, no trade barriers, and international relative price between importables and exportables is constant over time, it follows that the nominal interest rate satisfies Fisher's equation, i.e.,

$$i = \rho + \pi. \tag{A2}$$

Hence, by equations (6) and (A2), at equilibrium we have

$$-\pi = \rho - \frac{V\prime\big(m+Z(m^e)\big)}{u\prime(y)-1}. \tag{A3}$$

This is a representative-individual economy in which $m = m^e$. Thus, plugging (A3) in equation (A1), we have

$$\frac{\dot{m}}{m} = \mu + \rho - \frac{V\prime\big(m+Z(m)\big)}{u\prime(y)-1}. \tag{A4}$$

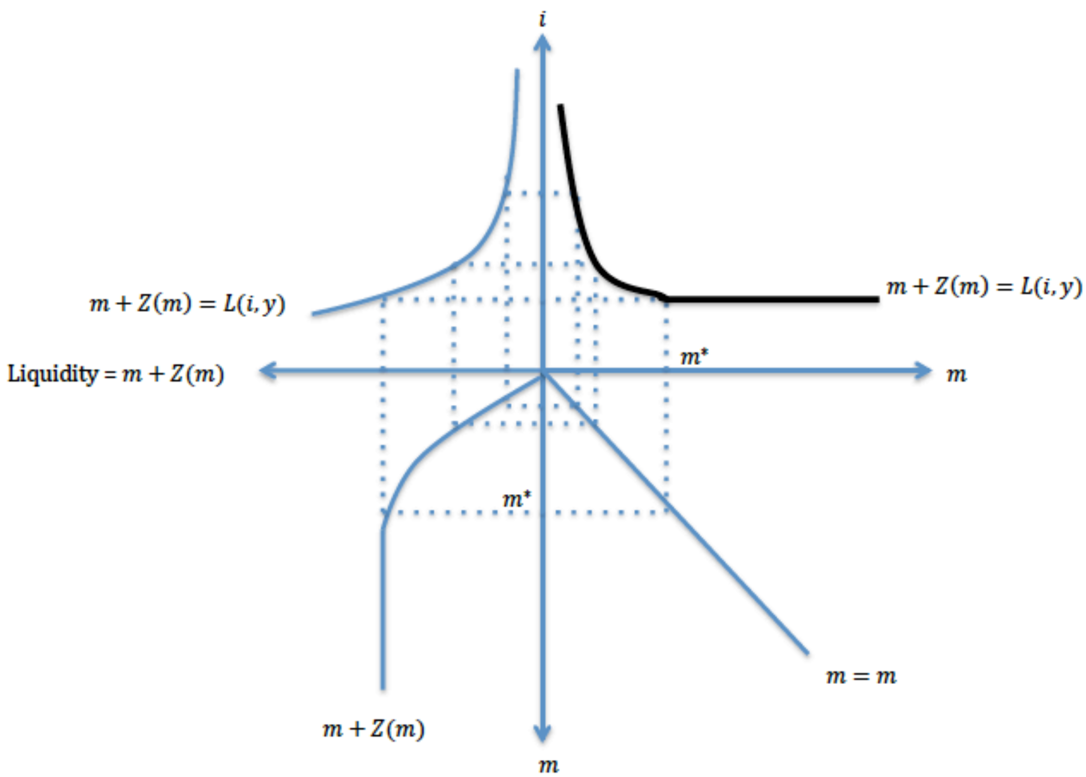
Therefore, at steady state (where $\dot{m} = 0$), we have

$$\frac{d\dot{m}}{dm} = -m\frac{V"(m+Z(m))[1+Z\prime(m)]}{u\prime(y)-1}. \tag{A5}$$

Let us examine the steady states $m1$ and $m2$ in Figure 1. Since the curve is downward sloping at $m1$, it follows that $V"(m + Z(m))[1 + Z'(m)] < 0$. Therefore, $d\dot{m}/dm > 0$, and $m1$ is unstable. But the same procedure leads to the conclusion that $m2$ is stable and gives rise to a continuum of equilibrium paths. Liquidity Deflation is behind this indeterminacy, even though these equilibrium paths do not display Liquidity Trap. Uniqueness would be ensured, however, if, for instance, $i > i^*$, and $V\big(m + Z(m)\big) = V(m^* + Z(m^*))$, for all $m \geq m^*$, as assumed in Figure 2.

Appendix B

Figure B1. Graphical Derivation of Figure 2



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