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

Guillermo Calvo
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Abstract. I discuss some simple microfoundations for Liquidity Deflation, a concept put forward in Calvo (2016 a and b), which can give rise to liquidity trap conditions under perfectly flexible prices. Unlike in Keynes (1936), this is a Supply Side Liquidity Trap. Moreover, modeling the policy interest rate as the rate of return on money-like instruments à la Calvo and Végh (1995), denoted by $i^m$, I show that $i^m$ may fail to generate full equilibrium if it is subject to a lower bound like the ZLB. However, even if lower bounds are not binding, a low $i^m$ may be counterproductive because it may impair the liquidity of the money-like instrument.

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, in a situation in which long-term Treasury bonds appear to be highly substitutable to Treasury bills and bank reserves. 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 satiation, utility maximization should lead to a rise in aggregate demand that matches full capacity output (in line with the Pigou effect). This inconsistency, though, is due to an assumption that is taken for 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

1 I am thankful to Ricardo Caballero, Sara Calvo and Martín Uribe for useful comments on a previous version.
circulation of monetary aggregates (e.g., M1 and M2) in the US, has fallen to levels not seen for more than half a century.\footnote{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.}

In recent work I have explored the possibility of there existing a disconnect between \textit{real safe assets} (i.e., the nominal supply of safe assets \textit{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 \textit{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 noticeable resistance in presenting the case. I guess that part of the reason is that in macroeconomics, at least, the concept of “money” is associated with an object which liquidity is tarnished by nothing except “inflation”. In particular, increasing the supply of a “reserve currency” is rarely associated with a loss of its “liquidity” or transaction services. This persuaded me that time was high for attempting to improve the \textit{microfoundations} of Liquidity Deflation.

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 increase in prices.

In the closing remarks I extend the discussion to Emerging Market economies, EMs, in which domestic assets could hardly be classified as \textit{safe}. Arguably, however, the search for yield triggered by low-interest-rate of safe assets may have turned some EM assets \textit{safier} (perhaps due to higher turnover), helping to explain the noticeable recent downward trend in EM inflation and lower pass-through coefficients.
II. LIQUIDITY DEFLATION

a. Intuitive Scenarios

1) Consider a simple economy in which carrying cash to the mall saves shopping time (see Végh 1989). Time saved also depends on how much cash is held by the other mall customers, a congestion effect. Customers would be better off coordinating the sums of cash that each of them carries to the mall. However, in an ‘atomistic’ environment, customers would have incentives to hold more than the cooperative optimum.

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, the value of Treasury bonds as collateral may increase less than in proportion to the increase in the (real) market value of Treasury bonds.

NB. 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 benefits are taken into account). Keynes (1936) offers an alternative explanation, which I labeled the Price Theory of Money (see 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 no backing. 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 monetary balances become large, for the simple reason that the flow of real transactions subject to sticky prices has an upper bound.

b. Parsimonious Microfounded Flexible Prices Model

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

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 pricing and units of account across world economy, like the US dollar, become stronger in terms of output during a Liquidity Crunch episode.
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

\[
l = c - V(m + Z(m^e)), \quad V'(0) > 0, V'' < 0, Z' < 0, Z'' < 0,
\]

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). Individuals can single-handedly determine \( m \), but, since they are atomistic, are constrained to take \( m^e \) as given. Individuals do not internalize it despite taking \( m^e \) into account for determining individual-optimal \( m \). The standard assumption in the literature is that \( Z' > 0 \), reflecting positive ”network” effects (see, e.g., Uribe 1997). In contrast, here \( Z \) is associated with negative externalities, e.g., ”market congestion” or increase in money’s ”haircut” as collateral.\(^6\)

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 unity. Moreover, the international real interest rate is positive, equals the

\(^5\) 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 would cloud the analysis with superfluous details.

\(^6\) In the short run, Liquidity Deflation is likely to dominate the network effect, because the latter calls for time-consuming coordination, while the former works under the status quo ante (i.e., initial coordination conditions) — no innovations are necessary.
representative individual’s subjective rate of discount, \( \rho \), and (importantly for our discussion here) exchange rate and prices are perfectly flexible. Thus, the budget constraint of the representative individual satisfies:

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

(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.\(^7\)

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:

\[
u'(c_t) - 1 = \lambda,
\]

(4)

and

\[
V'(m_t + Z(m^e_t)) = \lambda i_t,
\]

(5)

where \( \lambda \) 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):

\[
\frac{V'(m + Z(m^e))}{u'(y) - 1} = i,
\]

(6)

From (6), it follows that there exists a function \( L \) such that, at equilibrium where \( m = m^e \), the following money-market equilibrium condition holds:

\[
m + Z(m) = L(i, y), \quad L_i < 0, L_y > 0,
\]

(7)

\(^7\) 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 models, 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).
which is a familiar expression, except for the term \( Z(m^*) \). 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 (7) is depicted in Figure 1, where \( m^* \) maximizes \( m + Z(m) \) with respect to \( m \). The slope of the money demand function is downward sloping with respect to the nominal interest rate to the left of \( m^* \), as in conventional models. However, the slope is 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 \( i = i' \), where \( m1 \) and \( m2 \) are both consistent with full equilibrium. The two solutions are Pareto equivalent, and social welfare increases if the nominal interest rate \( i \) goes down, irrespective of whether equilibrium settles at the left or right of \( m^* \). However, given nominal money supply, the price level may be undetermined.

**Figure 1. Money Market (Dis) Equilibrium**

![Money Market (Dis) Equilibrium Diagram](image)
More interesting is the case in which $i < i^*$. By equation (7), given nominal interest rate $i''$ in Figure 1, $m^* + Z(m^*) < L(i'', y)$. Hence, there is no general equilibrium solution. If full capacity utilization holds, i.e., $c = y$, for instance, the money market would exhibit excess demand, which 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, this is a Liquidity Trap that, unlike Keynes (1936), is generated by liquidity supply phenomena. I will correspondingly call it Supply Side Liquidity Trap, SSLT.  

Setting the nominal interest rate such that $i \geq i^*$ will get the economy out of SSLT. Under normal circumstances, this could be achieved by increasing the rate of expansion of money supply, denoted by $\mu$. However, this may be more difficult if the economy starts at $i = i''$ in Figure 1.

To simplify the discussion, consider the case in which $m + L(m) = m^* + Z(m^*)$, for all $m \geq m^*$. This implies that the curve in Figure 1 becomes flat for all $m \geq m^*$, thus looking like a typical textbook Keynesian Liquidity Trap. Suppose that the increase in $\mu$ fails to change inflation expectations. Hence, given rationality, the representative individual should expect inflation also to remain constant at $\pi = i'' - \rho$. Thus, increasing $\mu$ will increase $m$ without bound relative to initial conditions, but it would fail to change the relevant liquidity concept (which will remain constant at $m^* + Z(m^*)$). I will show next that by modifying the equilibrium concept in a plausible manner, one can obtain a full-fledged equilibrium exhibiting capacity underutilization, without violating transversality conditions.

I will assume that under SSLT and excess money demand, individuals divert their attention to finding alternative liquid assets (e.g., crypto-currencies, searching for yield, etc.) in detriment of their endowments. Moreover, these negative effects on output do not subside until effective endowment shrinks and restores equilibrium in the money market. Thus, the equilibrium effective endowment, denoted by $y'$, must satisfy:

$$m + Z(m) = L(i'', y').$$

Clearly, $y' < y$. For the sake of concreteness, consider the case in which equilibrium settles down at $m = m^*$, and $y'$ attains its maximum given $i''$ (but still $y' < y$). This excess capacity equilibrium is not affected by changes in $\mu$. To be sure, if $\mu > \pi$, $m$ will grow without bound, but this does not violate any transversality condition because the stock of relevant liquidity will remain constant at $m^* + Z(m^*)$. Since

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

9 In the standard IS/LM apparatus, the adjustment mechanism is parallel to the one outlined above, but results rely on assuming sticky prices and demand-determined output. See Calvo (2018) for an analysis of Liquidity Deflation in terms of a New Keynesian model.
output stays constant and \( m \) increases without bound, velocity will fall over time. This is in line with recent events in reserve currency economies but, of course, a more plausible dynamic model is needed at this stage.

I guess that Keynes would have been pleased by this result. He spent much of Chapter 19 of his General Theory discussing several instances in which downward flexible wages would fail to achieve full employment, appealing to arguments that are somewhat alien to the preceding chapters in his book. In contrast, Liquidity Deflation is a natural corollary to the Price Theory of Money put forward in Chapter 17 (recall footnote 3, and NB in Section II.a above).

Although, as pointed out in footnote 7, 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 \( i^m \).\(^{10}\) It is easy to show that the money-market equilibrium condition (7) would become:

\[
m + Z(m) = L(i - i^m, y), \ L_{i-i^m} < 0, L_y > 0.
\]  

Clearly, then, lowering \( i^m \) reduces the demand for liquidity services and pushes the economy towards full employment. However, this policy may also face problems comparable to the familiar ZLB, either because there are institutional constraints preventing \( i^m < 0 \), or, more interestingly, because a low \( i^m \) may trigger Currency Substitution. The latter could dry up transaction services by, for instance, increasing the probability of runs against a subset of transaction instruments, a phenomenon illustrated by a number of currency runs in Emerging Market economies, EMs. Thus, the shortage of transaction assets may get worse.

**The Optimal Quantity of Money: A Digression.** Friedman (1969) shows that abstracting from tax distortions, and assuming that the marginal cost of issuing 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.

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

\[
u(c) - c + V(m + Z(m))
\]

with respect to \( c \leq y \), and \( m \geq 0 \). Since \( u'(y) > 1 \), optimal consumption \( c = y \). On the other hand, the optimal quantity of money satisfies:

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\(^{10}\) For a related model, see Calvo and Végh (1995). Variable \( i^m \) could also be interpreted as central bank’s interest on bank reserves.
\[ V'(m + Z(m))[1 + Z'(m)] = 0. \]  \hfill (10)

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.

Consider now the case in which Liquidity Deflation holds and, to simplify the discussion, let us assume that there is no satiation point, i.e., \( V' > 0 \) everywhere. One can show that the OQM calls for setting \( 1 + Z'(m) = 0 \), which, recalling Figure 1, holds at \( m = m^* \). By equation (6), decentralizing the OQM calls for setting the nominal interest rate such that (recalling Figure 1) \( i = i^* \), where

\[ \frac{V'(m^*+Z(m^*))}{u(y)^{-1}} = i^* > 0. \]  \hfill (11)

Depending on parameters, this may be consistent with inflation. Moreover, if money yields a rate of return \( i^m \), equation (11) becomes:

\[ \frac{V'(m^*+Z(m^*))}{u(y)^{-1}} = i - i^m > 0, \]  \hfill (12)

implying that the OQM is achieved under any rate of inflation as long a money bears a sufficiently high rate of return. However, as pointed out above, SSLT may prevent the central bank from reaching the OQM. Besides, the OQM \( m = m^* \) seats 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. However, Liquidity Deflation is also relevant near the limit, where QE is still capable of increasing liquidity supply. For the sake of concreteness, let us write the left-hand side of equation (7) as \( m + \beta Z(m) \), \( \beta \geq 0 \), and consider the effect of a slight drop in parameter \( \beta \). 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 \( \approx 0 \). Hence, recalling that \( Z(m) < 0 \), one can easily show that a fall in parameter \( \beta \) implies a "large" contraction in equilibrium real monetary balances \( m \). Thus, for instance, if nominal money supply were exogenous, a fall in parameter \( \beta \) would bring about a "large" increase in the price level.

**III. CLOSING REMARKS**

Having reached this point, the reader may feel that the above results are trivial. And I agree. However, I felt compelled to compose this note because what seemed trivial to me was not trivial to most of my interlocutors. If you ask your "representative" economist (especially prior the Great Deflation): "What happens after 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."

Liquidity Deflation helps to rationalize safe-asset shortage, i.e., shortage of full equilibrium liquidity services (see Caballero et al 2014, 2016, and 2017). However, this phenomenon is unlikely to be as relevant in EMs, even under severe liquidity crunch conditions. In the latter, and as a general rule, financial assets have been akin to junk bonds in developed markets. Hence, it is not surprising that in the last twenty-five years, EM financial crises drove agents to flee domestic currency and cause sharp exchange rate and price spikes (see Calvo 2016 b, Chapter 7). Domestic liquidity contracted but there was no excess demand for liquid domestic assets, as in a safe-asset-shortage episode.

However, a long period of safe-asset shortage, like that in the wake of the Lehman crisis, may have imbued EM currencies with additional liquidity resilience. Thus, for example, a search for yield (on liquid assets) may increase the turnover and, thus, the liquidity of EM government liabilities in a select group of countries, and help to lower their respective rates of inflation. Israel is an interesting case in point. In the 1980s Israel was a clear instance of chronic high inflation, occasionally reaching staggering levels (e.g., over 350 percent in 1985). At present, however, Israel is struggling to stop deflation! Inflation has undershot its inflation target by a wide margin, and is dangerously teetering around zero. This could, of course, be due to prudent fiscal and monetary policy. But it is hard to discount the higher-liquidity-resilience hypothesis highlighted above. Israel is an extreme case but not unique. Since the Lehman crisis, inflation has fallen sharply in a good number of EMs that benefitted from large capital inflows, even though they are not exemplars of fiscal prudence.\footnote{An interesting question is: Will inflation flare up again in low-inflation EMs whose assets gained quasi-safety status if, for instance, capital starts to flow back to developed economies?}
REFERENCES


