A Microeconomic Theory of the Liquidity Trap

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I. INTRODUCTION

Forty years after publication of Keynes General Theory, debate continues over the meaning and validity of Keynes' ideas. Among the most controversial of these is the "liquidity trap." The liquidity trap is a condition in which monetary expansion has little or no effect on real investment or income, but instead mainly induces increased idle balances.

The concept of a liquidity trap has had important influence on post-Keynesian thinking. For example, Johnson (1961) attributes to Keynes a dynamic analysis that explains why unemployment disequilibrium can be sustained for a long time despite monetary (or other policy) intervention. Similarly, Lerner (1961) describes policy signficance of the "Keynesian Special Case where fiscal policy has to bail out monetary policy." The liquidity trap underlies the interpretation of Keynes that attributes low leverage to monetary policy and much greater force to fiscal policy.

But despite agreement over the theoretical significance and policy relevance of liquidity-trap behavior, two main areas of controversy about the liquidity trap persist. One area revolves around Keynes' own contribution; in particular, whether Keynes himself presented a cogent explanation of the liquidity trap and even whether he espoused its importance. The second area of controversy concerns adequacy of any theory advanced to explain the liquidity trap.

Leijonhufvud (1968) has pointed out the ambiguity of Keynes own contribution. In the Treatise on Money, Keynes argues that if a contraction were allowed to gather momentum, only "open market operations to the point of saturation" would exert any appreciable effect. Keynes thus defends the existence of liquidity-trap behavior, but does not firmly

explain its source. In Chapter 15 of the General Theory, Keynes further remarks:

> "There is the possibility...that after the rate of interest has fallen to a certain level, liquidity preference is virtually absolute in the sense that almost everyone prefers cash to holding a debt at so low a rate of interest. In this event, the monetary authority would have lost effective control....But whilst this limiting case might become practically important in future, I know of no example of it hitherto. (p. 207)"

In this quote Keynes outlines one theory of liquidity-trap behavior but he does not show conviction in the relevance of his hypothesized cause. Therefore, according to Leijonhufvud, explanation of the liquidity trap is only weakly developed by Keynes, and limits to interest-rate declines that produce liquidity-trap behavior are not central to Keynes' argument.

The best developed theory of the liquidity trap in the literature derives from Hicks (1937) interpretation of the General Theory. According to the Hicksian explanation, interest rates may not fall in the face of monetary expansion when they are initially so low that investors fear capital losses on bonds that would occur when interest rates rise back to a "normal" historical level. Under such conditions, monetary expansion would not lower interest rates and would thereby fail to stimulate investment and raise income. Robertson (1940) has criticized the Hicksian model, arguing that it is unrealistic in fixing a particular normal interest rate that investors believe will be restored:

> "[In the Hicksian explanation] the rate of interest is what it is because it is expected to become other than it is; if it is not expected to become other than it is there is nothing left to tell us why it is what it is. The organ which secretes it has been amputated, and yet it somehow exists--"a grin without a cat." (p. 25)

Robertson thereby argues that the Hicksian theory of the liqudity trap is based on a static and unrealistic model of investor expectations.

Dornbush and Fischer (1978) extends Robertson's criticism by asserting that no persuasive explanation of the liquidity trap has been advanced to date in the literature. Similarly, Wright (1961) notes that weak investment incentives are central to the fiscalist position that

monetary policy has low leverage, but argues that "you may search the neo-Keynesian scriptures with lamps for any adequate theory of the assumed collapse of the marginal efficiency of capital."

This paper attempts to shed light on the liqudity-trap debate by offering a microeconomic explanation of liquidity-trap behavior. The explanation has two parts: first, a demonstration of how capital production can overexpand and thus lead to collapse of new investment; and second, an illustration that such an overinvestment mode exhibits the low leverage of monetary policy and the building up of money balances characteristic of the liquidity trap.

The theory of the liquidity trap developed here either addresses or circumvents the areas of controversy presented earlier. It addresses Leijonhufvud's analysis by providing an explanation that is fundamentally Keynesian in thrust. In the explanation, the underlying source of low monetary leverage is a collapse of investment incentives, consistent with Keynes' emphasis on faltering marginal efficiency of capital as a source of major depressions. The explanation developed here is not subject to Robertson's critique in that it does not rely either on static expectations or on a minimum floor for interest rates as a requirement for liquidity-trap behavior. Lastly, the theory responds to the criticisms of Dornbush and Fischer and of Wright by articulating a microeconomic basis for the liquidity trap. Some evidence is also presented that the 1930s may have been characterized by the liquidity-trap conditions outlined here, although the thrust of the paper is theoretical rather than empirical, and more extensive empirical study is a subject of follow-on work.

Section II summarizes the static (Hicksian) theory of the liquidity trap. With this background, Section III develops five main hypotheses that comprise the alternative disequilibrium theory of the liquidity trap. The five hypotheses have been tested statistically (test results are reported elsewhere) and combined in a computer-simulation model of capital investment activity to study how they interact to produce liquidity-trap behavior. Finally, Section IV outlines implications and future work.

II. The Static Theory of the Liquidity Trap

II.A Description

The basis for most debate over the liquidity trap is the Hicksian IS-LM framework. The IS curve gives combinations of income y and interest rate r that would equate savings and investment. The IS curve is downward sloping on the assumption that a lower interest rate encourages investment and a higher level of income is required to elicit a corresponding volume of savings. The LM curve gives combinations of y and r that would equate liquidity demand with a pre-determined money supply. The LM curve slopes upward on the assumption that higher interest rates discourage holding of money and require an increased level of income to sustain liquidity demand.

The source of the liquidity trap criticized by Robertson is shown in Figure 1. Here the LM curve flattens out at some minimum interest rate on the assumption that at that interest rate investors will absorb unlimited amounts of money, rather than invest in securities, due to fear of capital loss. If the IS curve intersects the LM curve in the horizontal (or nearly-horizontal) region, then monetary expansion has no (or little) effect on income. Expansion of money shifts the LM curve to LM' but

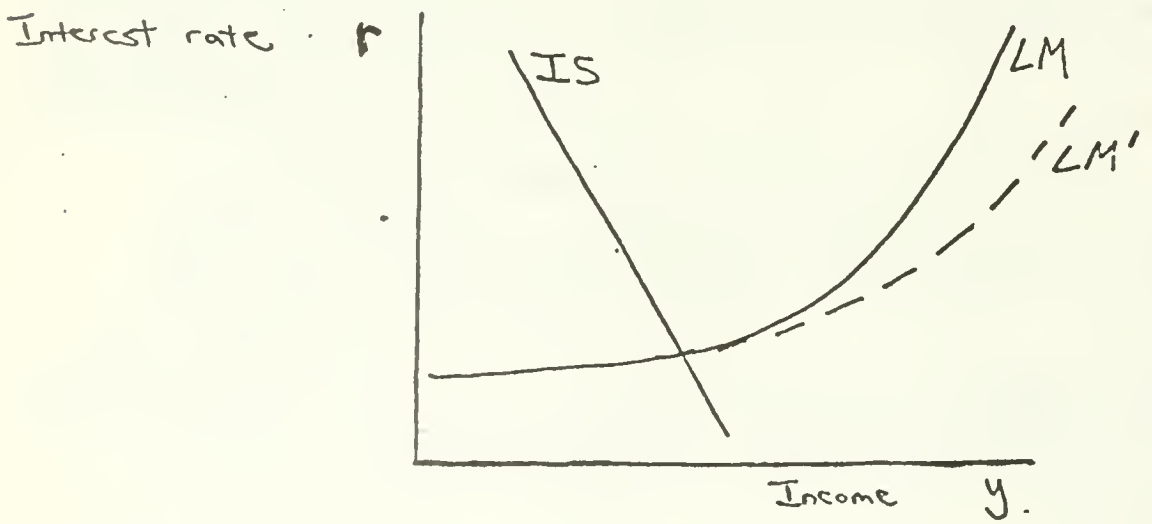

Figure 1. Horizontal LM curve produces liquidity-trap behavior

equilibrium income is the same since interest rate can not fall below its minimum.

A second source of liquidity-trap behavior in the IS-LM framework arises if investment is extremely interest-inelastic. Under such conditions, the IS curve becomes nearly-vertical since a large change in interest rates is needed to generate sufficient investment to absorb increased savings resulting from only a small rise in income. Figure 2 shows that when the IS curve is almost vertical, monetary expansion has little effect on income even if it succeeds in lowering the LM curve.

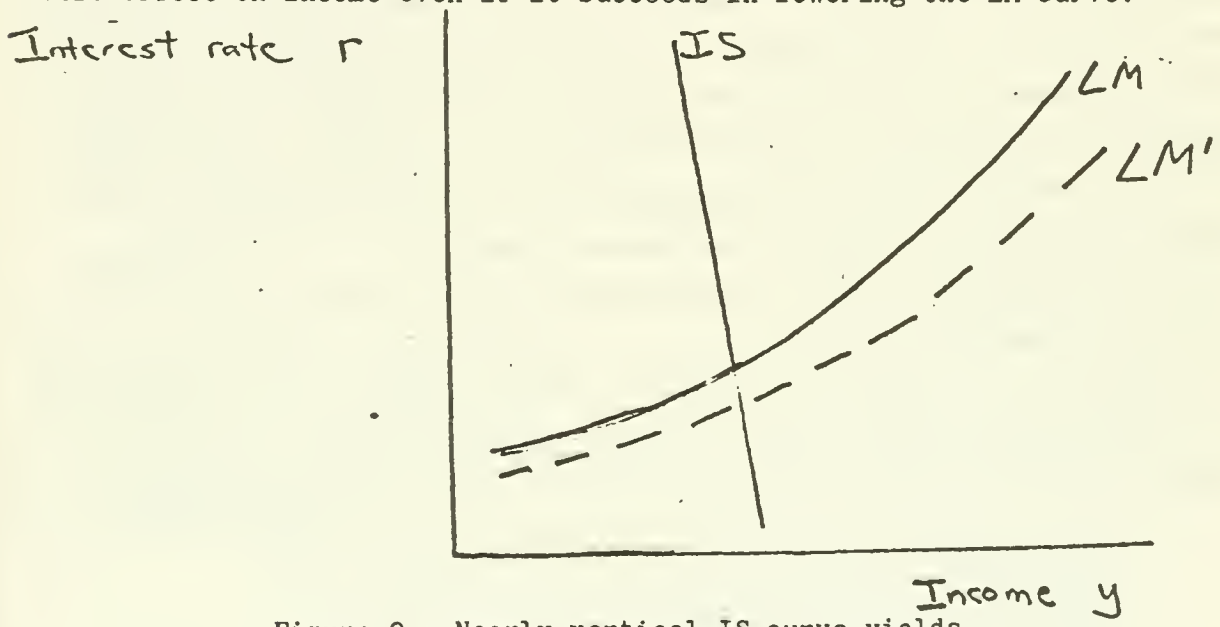

Figure 2. Nearly-vertical IS curve yields low leverage of monetary expanion

II.B Critique

The above analysis summarized the Hicksian version of the liquidity trap. The theory has several weaknesses that limit its explanatory power.

First, in the spirit of Robertson's criticism, the LM curve is supposed to apprach a horizontal line on the assumption that liquidity preference is essentially infinite below a minimum interest rate. However, the IS-LM model contains no explanation of how interest rate expectations are formed, and contains no provision for a changing interest rate expectation in light of the actual history of interest rates. Therefore,

any explanation of the liquidity trap that relies on infinite liquidity preference is deficient unless it internally explains why such a condition should ever arise, much less be sustained.

Second, the LM curve is built on the equilibrium assumption that liquidity demand always equals the existent money supply. At best, therefore, the liquidity-trap explanation revolving around liquidity preference shows how monetary policy would exert little impact on real activity between comparative equilibria. The theory says nothing about the actual time path of change in investment, GNP, and money demand that would result from a monetary injection. By virtue of its equilibrium focus, the Hicksian analysis omits many of the disequilibrium phenomena that Keynes associated with shifting liquidity preference. For example, Keynes notes that one of the motives for holding money is the precautionary motive "to provide for contingencies requiring sudden expenditure..." In a downturn, pressures can arise to rebuild liquidity, and thereby increase the precautionary motive to hold money even as incomes are falling. Rebuilding of liquidity is a disequilibrium phenomenon whose effect is not readily captured in an equilibrium model. Keynes describes dynamics of change in interest rates and liquidity demand in Chapter 22 of the General Theory:

> "...the dismay and uncertainty as to the future which accompanies a collapse in the marginal efficiency of capital naturally precipitates a sharp increase in liquidity preference...[Rise] in the rate of interest may seriously aggravate the decline in investment. [p. 316]."

Both pressures to rebuild liquidity as well as changing liquidity preference due to uncertainty could be captured roughly in the IS-LM framework through shifting the LM schedule to reflect corresponding shifts in the demand for money schedule. However, such manipulation of the IS and LM curves is at best awkward; moreover the static theory does not explain when the curves should be shifted so that explanation by means of shifting curves is largely retrospective.

A similar criticism to the above can be argued for the IS curve. The IS curve assumes equilibrium between investment and savings. As such it is incapable of describing the disequilibrium conditions that prevail during a downturn in which producers build up excess inventory due to

shortfall of consumption (or equivalently excess savings) relative to planned investment in inventory. Once again, therefore, the Hicksian framework fails to capture the disequilibrium dynamics of a crisis.

Lastly, the Hicksian explanation for low monetary leverage due to inelastic investment demand fails to explain why the inelasticity arises. It can certainly be argued that the demand schedule is inelastic because empirical measurements indicate that to be the case. However, response of investment to interest rates will certainly be different in a business boom, when sales are expanding and capacity is short, from a business downturn when capital plant is adequate or excess. Therefore, interest elasticity of investment demand should be expected to shift with the varying phases of economic growth and depression. But the IS curve simply takes the interest elasticity as a given with no account of its source.

All of the above four criticisms can be summarized by noting that the Hicksian explanation of the liquidity trap is essentially static rather than evolutionary. It cannot show how disequilibrium adjustments would affect response to monetary policy; nor how a condition such as low interest elasticity that mitigates effectiveness of monetary policy could arise. Section III moves toward an evolutionary explanation of the liquidity trap by developing a disequilibrium model of capital investment.

III. Capital-Overinvestment Theory of the Liquidity Trap

This section builds on the critique of the Hicksian model of the liquidity trap to develop a disequilibrium model. The model focuses on a set of microeconomic forces that induce cumulative expansion of the capital sectors of the economy, and eventually lead to overexpansion and collapse of new capital formation. The portion of the cycle beyond the point of capital overexpansion is shown to exhibit two primary responses to monetary stimulus, both characteristic of the liquidity-trap mode:

1. Weak and short-lived impact on real investment; and
2. Pressures to rebuild liquidity that absorb additional money and lower velocity of transactions.

III.A. Cumulative Pressures on Capital Investment

Hypothesis 1

One set of pressures that can reinforce capital expansion derives from determinants of desired output rate in capital sectors. In Equation 1 desired production of capital goods DPCG equals average sales of capital goods ASCG plus correction terms for output inventory and order backlog. When output inventory of capital goods OICG and backlog of orders for capital goods BOCG equal their desired levels, DPCG equals ASCG meaning that output is geared simply to meet average sales rate. When output inventory of capital goods OICG differs from the desired inventory of capital goods DICG desired production will likewise be above or below average sales. Low inventory necessitates production in excess of sales rate to rebuild inventory, which surplus inventory produces pressures to cut back output to liquidate output inventory. The impact of inventory condition on desired production is represented in Equation 1 as the inventory discrepancy, DICG - OICG, divided by the time to correct inventory of capital goods TCICG. Order backlog affects desired production in an analogous manner to inventory: high backlog necessitates production above average sales rate while low backlog indicates weak demand that contracts output. The backlog impact is measured by backlog of orders for capital goods BOCG minus desired backlog for capital goods DBCG divided by

the time to correct backlog for capital goods TCBCG.

$$DPCG(t) = ASCG(t) + (DICG(t) - OICG(t))/TCICG + (BOCG(t) - DBCG(t))/TCBCG \quad (1)$$

To see how production policies for capital goods reinforce overall trends in capital investment, suppose that orders for capital are rising. Increased orders augment average sales, deplete output inventories of capital goods as those goods are shipped, and increase order backlogs for capital goods to the extent that appropriate output inventories are not immediately available. All three effects--higher sales, lower inventory, and increased backlog—raise desired production of capital goods DPCG. In turn, more production necessitates an increased capital stock.

Equation 2 formalizes the relationship between desired production and desired capital stock. Desired capital in capital sector DKCS equals the present stock of capital in capital sector KCS multiplied by the production ratio in capital sector PRCS and the perceived capital return to cost in capital sector PCRCCS. Production ratio in capital sector PRCS measures desired production of capital goods DPCG divided by the present production rate of capital goods PRCG (Equation 3). For example, a production ratio of two indicates that capital and other factors of production must be expanded by a factor of two to double output to the desired production rate. The perceived capital return to cost in capital sector PCRCCS is discussed in detail later; basically, it measures the marginal revenue product of capital in the capital sector in relation to its marginal cost as a measure of incentives for increasing or decreasing capital/output ratio.

$$DKCS(t) = KCS(t) * PRCS(t) * PCRCCS(t) \quad (2)$$

$$PRCS(t) = DPCG(t)/PRCG(t) \quad (3)$$

Equations 1-3 now show how incentives for expansion of capital goods production are self-reinforcing. In Equation 1, increased orders for capital raised desired production of capital goods. But in turn, for the capital sector to produce additional output it requires more capital as a factor of production in accordance with Equation 2-3. Finally, viewing order rate for capital as part of a stock adjustment process implies that an increase in desired capital in capital sector will lead to still further orders of capital goods, further increase in desired production of capital

goods, and so on.

Equations 1-3 essentially represent a generalization of the accelerator principle of capital investment first introduced by Clark (1917). [Extensions of the basic accelerator model are described in Chenery (1952), Koyck (1954), Jorgenson and Siebert (1968), and Bischoff (1971).] In the accelerator model, desired capital stock assumed to be a function of average order rate or sales rate. In Equation 1, both inventory and backlog conditions, in addition to average sales rate, influence desired production, and hence desired capital stock. The extension is important to capture investment behavior in a period of rising orders for capital: production will initially lag orders but will later need to rise above order rate to replenish output inventory and to reduce to an acceptable level a high order backlog that builds when production capacity is below orders. The model thus seems to provide a more realistic portrayal of response of capital goods producers to disequilibrium between capital production capacity and demand for capital goods. Impact of inventory and backlog conditions on production behavior is discussed in Mack (1967), Stanback (1961), and Zarnowitz (1961).

Hypothesis 2

Hypothesis 1 argued that orders for capital affect levels of demand and supply--average sales, inventory, and backlog--and thereby affect desired production of capital goods and capital investment in capital producing sectors to expand or contract capacity. Apart from current demand or supply, capital investment may also be affected by expectations of growth in sales. For example, suppose that a particular firm's sales are growing at a rate of 3% per year. Then capital stock and other factors of production must be expanded at 3% per year to meet demand even if inventory and backlog are in balance at each point along the growth path.

Equation 4 integrates influences of both levels of demand and growth expectations on capital investment in the capital sector. Orders for capital in capital sector equal the sum of replacement orders for capital in capital sector ROCCS plus expansion orders for capital in capital sector EOCCS plus orders for supply line in capital sector OSLCS.

The first term, ROCCS, represents orders to replace depreciating capital stock. OCCS would equal the replacement rate ROCCS if capital in the capital sector were at its desired level and if expectations of growth in sales were zero. The third term, OSLCS, is discussed later in detail and represents orders for capital on the part of capital users to assure prompt deliveries and maintain an appropriate amount of capital on order.

The middle term in Equation 4, expansion orders EOCCS, is formulated in Equation 5 as the sum of two components. The first term is equal to the desired additional number of capital units to be acquired (or disposed), equal to desired capital in capital sector DKCS minus capital in capital sector KCS, divided by the time to correct stock of capital in capital sector TCSCCS. The second term equals capital in capital sector KCS multiplied by the expected growth in sales in capital sector EGSCS. Since desired capital in capital sector DKCS depends on desired production of capital goods it represents the influence of orders for capital (OCCS) on levels of demand in accordance with Equation 1. The second term in Equation 5 represents influence of growth or decline in demand for capital on OCCS, apart from the present level of demand. Expected growth in sales in capital sector EGSCS is mainly an extrapolation of past growth in sales. This treatment of growth expectations accords with Keynes perception in the General Theory that investment and financing are often based on an assumption "that the existing state of affairs will continue indefinitely." (p. 152). Thus growing sales create an expectation of further growth in the future, and detection of the trend in sales lags the actual trend. Mitchell (1941) provides discussion of managerial response to growing sales.

$$OCCS(t) = ROCCS(t) + EOCCS(t) + OSLCS(t) \quad (4)$$

$$EOCCS(t) = ((DKCS(t) - KCS(t))/TCSCCS(t)) + KCS(t)\cdot EGSCS(t) \quad (5)$$

Hypothesis 2 extends hypothesis 1 by incorporating growth expectations. During a period of rising demand for capital, orders for capital in capital sector will increase not only in response to average sales and inventory and backlog condition but will further be geared to the expected growth rate in demand. Thus for a given level of demand, orders for capital in capital sector OCCS will be higher when sales are rising and in turn the increased rate of ordering reinforces growth in sales as

perceived by capital producers.

Hypothesis 3

The third source of self-reinforcing growth in capital investment derives from long lead times during periods of physical capital shortage that encourage accelerating investment plans. In ordering capital equipment, a firm typically takes account not only of its existing capital stock in relation to its desired stock, but also of the number of orders that have already been placed for capital goods. For example, when a new capital project is initiated, producers do not continue to generate additional orders for the same project during the time that capital is being constructed, even though a discrepancy persists between desired and actual capital stock over the duration of the lead time for capital goods. Equation 6 formalizes this supply line adjustment. Orders for supply line in capital sector OSLCS equal desired supply line in capital sector DSLCS minus supply line for capital in capital sector SLCCS, divided by the time to corret the supply line in capital sector TCSLCS. The supply line for capital in capital sector SLCCS includes both projects that are being planned within the firm as well as projects for which orders have been placed with suppliers. Referring back to Equation 4, then, as orders for capital are placed, the supply line for orders is augmented, and thereby order rate OCCS is reduced while the orders are being filled. Equations 4-6 describe the ordering process for capital in the capital sector, but a similar stock adjustment and supply line adjustment process occurs in all sectors that use capital as a factor of production.

$$OSLCS(t) = (DSLCS(t) - SLCCS(t))/TCSLCS \quad (6)$$

What determines the desired amount of equipment on order? One factor is the desired rate of acquisition of capital goods. In terms of Equation 4, the desired rate of acquisition would be measured by the sum of replacement orders plus expansion orders for capital, that is (ROCCS + EOCCS). The second factor is the lead time or delivery delay for capital goods. When lead times rise, capital goods must be ordered further ahead to sustain a desired rate of acquisition over time. Thus in Equation 7, the desired supply line in capital sector DSLCS equals the desired rate of acquisition of new capital, represented by ROCCS plus EOCCS, multiplied by

the perceived delivery delay for capital PDDC. Again, a similar process would prevail in other producing sectors wherein lead times for capital affect the magnitude and timing of new orders for capital goods.

$$DSLCS(t) = (ROCCS(t) + EOCCS(t)) \cdot PDDC(t) \quad (7)$$

Delivery delay for capital tends to run high when backlog for orders of capital goods BOCG is out of line with inventory of output of capital goods IOCG, the latter representing the physical output available to meet demands for capital goods. Mitchell (1923) and Mitchell (1927) first discuss this influence. Therefore, in Equation 8, delivery delay for capital DDC is represented in symbolic form as an increasing function f of the ratio of backlog to inventory, BOCG/IOCG.

$$DDC(t) = f(BOCG(t)/IOCG(t)) \quad f'(\,) > 0 \quad (8)$$

Hypothesis 3 is now completely formulated. During a period of rising demand for capital, backlog for orders for capital goods BOCG runs ahead of available inventories and production capacity, leading to increased delivery delay for capital DDC. The longer lead time for acquiring capital goods induces users of capital to place orders further ahead and to replicate orders with multiple sources of supply. Both influences are subsumed in the effect of delivery delay for capital DDC on the desired supply line in Equation 7. In turn, a higher desired supply line for capital leads to additional orders to fill the supply line (Equation 6), and thereby an increased total order rate that further reinforces growth in backlog for capital goods.

Hypothesis 4

Expansion of capital investment may also be reinforced by pressures that favor capital intensive production during an upswing. When desired production of capital goods exceeds actual production rate, desired capital in capital sector DKCS will exceed capital in capital sector (Equation 2). Analogously, in Equation 9, desired labor in capital sector DLCS equals labor in capital LCS multiplied by the production ratio in capital sector and by the perceived labor return to cost in capital sector PLRCCS. Thus, pressures to expand output induce both additional capital investment and additional employment. Labor can normally be added more readily than capital equipment during an upswing, since according to

Keynes, capital is produced by a relatively "roundabout" process of production. Simply stated, delay in filling vacancies for labor is substantially below the normal delivery delay for capital goods. As labor increases to relative to capital, pressures to rebalance the factors create incentives for more capital intensive production, thereby augmenting the demand for capital goods. Moreover, as labor is adquired, delays in filling vacancies lengthen, labor markets tighten, and wages are bid up. Both lesser availability of labor and increasing wages further reinforce pressures for capital intensity.

$$DLCS(t) = LCS(t) * PRCS(t) * PLRCCS(t) \quad (9)$$

Equation 10 formalizes the impact of capital/labor ratio and wage rate on capital investment. In Equation 2 desired capital in capital sector DKCS was assumed to depend on the perceived capital return to cost in capital sector PCRCCS. PCRCCS is a lagged value of capital return to cost in capital sectors CRCCS which is a measure of incentives for increased capital intensity. In Equation 10, CRCCS equals price of capital goods PCG multiplied by the marginal product of capital in capital sector MPCCS, both divided by the marginal cost of capital in capital sector MCCCS. The numerator of Equation 10 measures the marginal revenue product of capital--the annual revenue derivable from adding an additional unit of capital. The denominator represents the depreciation and interest costs of holding capital in inventory for a year. The ratio of marginal revenue product to marginal cost measures the incentive to increase capital relative to production. The formulation in Equation 10 is similar to impact of factor costs on capital investment in the neoclassical investment function (see Jorgenson and Siebert (1968) and Jorgenson, et al., (1970)), except that delays in perceiving marginal productivity of capital and in determining an optimal capital output ratio are explicitly represented in the formulation of PCRCCS. [Senge (1978) describes the behavioral importance of delays in determining optimal capital/output ratio]. When labor expands relative to capital stock, the marginal productivity of capital MPCCS is increased, thereby encouraging addition of capital. Moreover, a rising wage lowers the perceived labor return to cost in capital sector PLRCCS, thereby discouraging addition of labor, and favoring investment in capital.

CRCCS(t) = (PCG(t)*MPCCS(t))/MCCCS(t) (10)

To summarize Hypothesis 4, then, pressures for additional output lead to increased employment, tight labor markets, and increasing wages, which favor addition of capital plant to rebalance capital and labor and to take advantage of the increasing wage. But more orders for capital further augment desired production of capital goods, thereby sustaining the increase in employment, wages, and caital investment.

Hypothesis 5

As a final hypothesis, rising wages and long delivery delay during the upswing lead to increases in the price of capital goods. In turn, high price of capital encourages expansion of capital sectors. High price of capital goods also enhances return on investment in capital sectors and thereby sustains flow of external financing to support the increase in real investment activity.

Equations 11-13 express the argument. In Equation 11, price of capital goods is shown symbollically as a function g of unit costs of production in capital sector UPCCS and delivery delay for capital DDC. Increasing costs of production due to higher wages create a pressure to raise price of capital goods PCG. Similarly, during the upswing, high delivery delay for capital DDC manifests excess demand for capital goods, indicating that backlog of orders for capital goods BOCG (measuring demand) is excessive compared with inventory of output of capital goods IOCG (measuring supply). The imbalance of demand over supply further creates pressure for increasing price of capital goods PCG. In turn, rising PCG sustains capital in capital sector through increasing the capital return to cost in capital sector CRCCS.

As a final influence on capital investment, Equation 12 extends the previous formulation of orders for capital sector OCCS to include liquidity pressures. Here, OCCS equals the sum of replacement orders ROCCS, expansion orders EOCCS, and orders for supply line OSLCS multiplied by the effect of liquidity on ordering in capital sector ELOCS. ELOCS has a normal value of 1 when the capital sector has adequate liquidity, meaning money and short-term liquid assests, to sustain the pace of real activity.

ELOCS declines below 1 in the face of inadequate liquidity that would curtail capital investment, and rises slightly above 1 in the face of more than adequate liquidity that would provide a slight incentive to increase aggressiveness of capital ordering. During the upswing, rising price of capital goods sustains profitability and thereby sustains the inflow of external financing that prevents for a long time advent of liquidity shortages that could throttle capital investment. In the General Theory, and in subsequent responses to critics of that theory, Keynes attached great significance to impact of financial conditions on capital investment, noting that "It is to an important extent the financial facilities that regulate the pace of new investment" (Keynes (1937), p. 248). Minsky (1975) similarly emphasizes importance of availability of external funds to supplement internal funds during periods of rapid capital investment to sustain the real investment flow.

$$PCG(t) = g(UCPCS(t), DDC(t)) \quad (11)$$

$$OCCS(t) = (ROCCS(t) + EOCCS(t) + OSLCS(t))\cdot ELOCS(t) \quad (12)$$

To summarize the fifth hypothesis, rising wages and high delivery delay for capital raise the price of capital goods. Higher price for output in capital sectors increases desired capital and also attracts external funds that supplements internally generated funds to finance new investment. Both effects stimulate cpaital investment.

III.B Capital Buildup and Decline

The preceding hypotheses have been combined in a computer simulation model of capital investment activities. The model consists of two production sectors: one producing consumer goods and the other capital goods. Each sector uses labor and capital as factors of production. Substitution between labor and capital in production is possible in accordance with a modified Cobb-Douglas production function that allows for variable utilization of factors. Structure of the capital goods sector is based on Equations 1 through 12 above. Equations for labor acquisition and capital investment in the consumer goods sector are structurally parallel to those for the capital goods sector. A priori values for all model parameters were chosen to accord with values suggested by earlier corporate modeling studies with firms in goods and capital sectors. Least squares

estimation was also used to estimate parameters. Estimated and a priori parameter values are generally quite close together, providing an important check on plausibility of model parameters. Senge (1978) reports estimation and statistical test results. Hypotnesis tests support each of the five hypotheses advanced earlier.* For example, the results support the hypothesis that desired production rate is influenced not only by average sales as in the accelerator model, but also by relative inventory and backlog conditions (see Hypothesis 1).

Figure 3 show response of capital investment to a step increase in orders for consumer goods starting from equilibrium. In this model, interest rates are held constant and order rate for consumer goods is the only exogenous input influencing behavior. Figure 3 shows sixty simulated years. From about years 10 to 27 output of capital goods expands rapidly. At year 10, delivery delay for capital is slightly below its normal value of 1.5 years. Delivery delay rises up to a peak of nearly two years around year 20. The high delivery delay is symptomatic of rising orders for capital, depleting finished output inventories of capital goods, and rising order backlogs in caital sectors. Inadequate inventories of capital goods and high backlog fuel expansion of capital output, according to Hypothesis 1, reinforcing expasion of capital orders as the capital sector needs additional capital to produce. Second, rising orders for capital create growth expectation that also augment demand for capital, consistent with Hypothesis 2. Third, high delivery delay for capital during the buildup phase from years 10 to 28 encourages advance ordering of capital goods that sustains the imbalance between supply and demand that underlies the high delivery delay. Fourth, Figure 3 shows that labor in the capital sector expands more rapidly than the stock of capital in the capital sector during the production upswing; expanding labor enhances the marginal productivity of capital and favors more capital intensive production. Rising wages for labor (not shown in Figure 3) also foster more capital

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* Due to data limitations, impact of liquidity conditions on capital investment could not be tested. All other hypotheses tested were supported. Liquidity constraints have recently been incorporated in several macro-econometric models (for example, see Data Resources Review, December 1977.

intensive production. Finally, a rising price of capital goods (not shown in Figure 3) sustains profitability in the capital sector and thereby encourages capital investment.

Together, the five hypotheses therefore embody cumulative pressure that continue to drive up the demand for capital goods once a boom has started. The duration of the upswing is a function both of the long time required to plan and construct new capital goods as well as the sustained forces that continue to drive up capital investment and output.

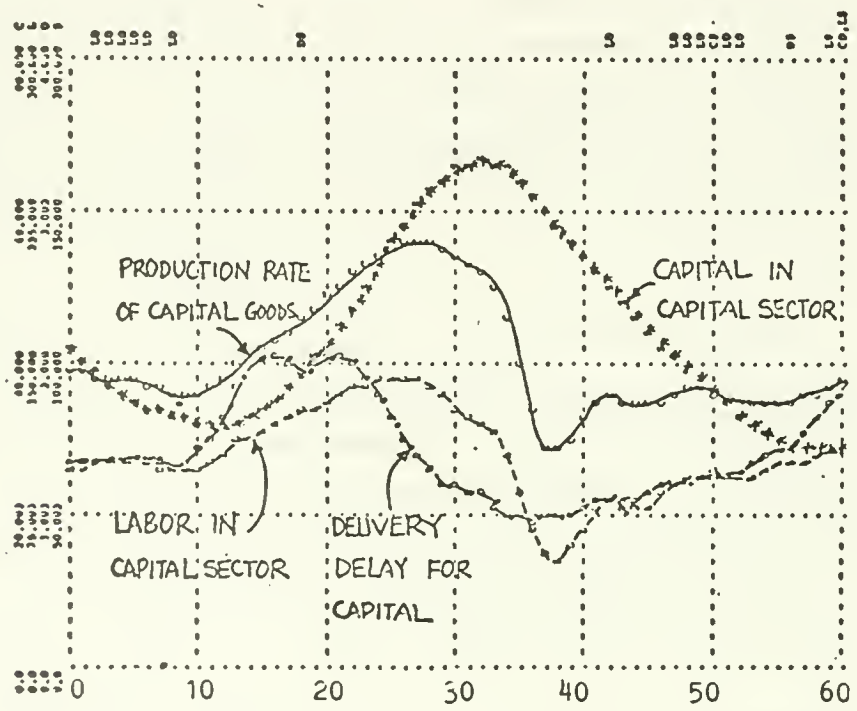

Figure 3. Capital buildup and overexpansion

Capital production eventually overexpands in Figure 3. At the peak of production at year 27, delivery delay has been lowered back to its normal value. However, restoring delivery delay to a normal level requires producing for a period of time in excess of orders, both to reduce order backlog and thereby lower demand, and to build up output inventory and thereby increase available supply of capital goods. Therefore, once delivery delay has been restored to normal, production rate in the capital sector exceeds the output rate needed to sustain the existing capital stock against depreciation. Production has thereby come to exceed order rate for

capital goods, and a condition of overcapacity develops. At this point, all of the mechanisms that previously sustained buildup of capital production now reverse their effects to accelerate decline in capital formation. For example, as order backlog for capital goods continue to fall and output inventory overbuilds, desired production of capital goods declines, thereby lowering desired capital in capital sector and further decreasing orders. Moreover, falling delivery delay means that advance ordering is no longer necessary, so orders for supply line wane. Analogously, each of the mechanisms that encourages capital production when capacity is short of demand act to depress new orders for capital goods once capacity comes to exceed orders.

The scenario in Figure 3 thus points to capital goods production as a potentially key driving force generating major depressions. The mode of capital boom followed by depression runs much longer than the usual short-term business cycle, and is powerfully driven by capital investment interactions (see Mass (1978) for further description.

Keynes described the General Theory as "the theory of why output and employment are so liable to fluctuation." In turn, he attributed a dominant role to investment as the driving force in producing fluctuation:

> "The theory can be summed up by saying that, given the phychology of the public, the level of output and employment as a whole depends on the amount of investment. I put it in this way, not because this is the only factor on which aggregate output depends, but because it is usual in a complex system to regard as the causa causans that factor which is most subject to wide fluctuations."

The theory underlying Figure 3 of cumulative pressures on capital investment that eventually induce overinvestment is therefore consistent with the capital investment emphasis of the General Theory. Lerner (1961) and others also attribute major economic downturns to massive failures of capital investment. But the theory above attempts to fill in part of the missing link identified by Wright (1961)--namely, why such failures occur.

III.C Impacts of Monetary Stimulus

Figure 4 extends the argument by showing reponse of the production

system in Figure 3 to a monetary stimulus implemented just ahead of the peak in capital production, at year 26. Interest rates, as noted earlier, are fixed in the model. But the stimulus is implemented through an assumption that expansive monetary policy would raise liquidity and stimulate orders for capital by 2% for any other set of investment incentives.

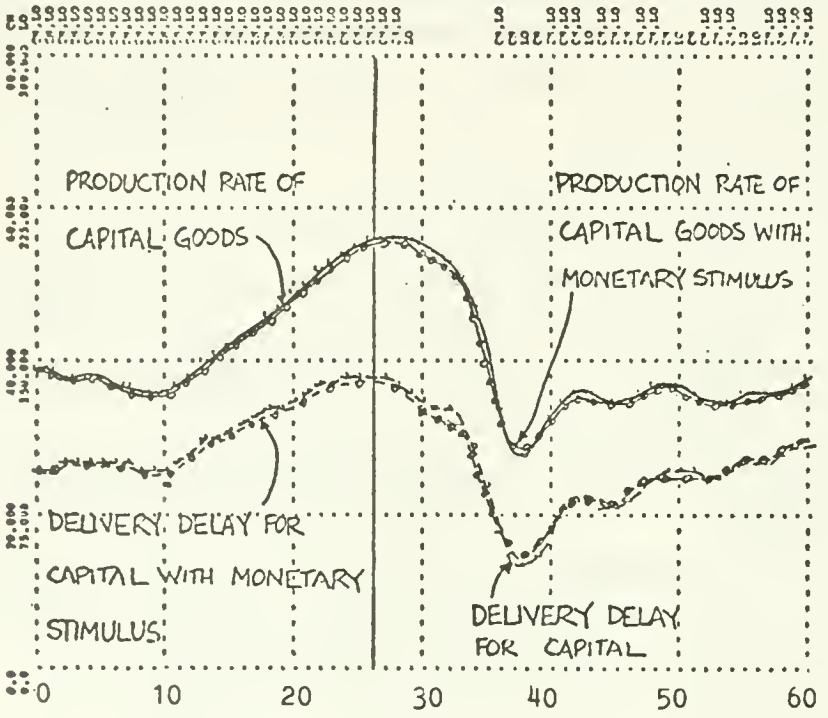

Figure 4. Weak leverage from small monetary stimulus

Figure 4 superimposes the time paths of production rate of capital goods and labor in capital sector both with and without the monetary stimulus. Up to the point where the stimulus is introduced, marked by the solid vertical line, curves for production and labor are identical for the two cases. However, even following application of the stimulus, the curves remain very close together, evidencing weak impact on either capital investment rates or employment in the capital sectors as a consequence of the monetary injection. The weak impact of monetary stimulus on real activity in Figure 4 is behavior characteristic of the Keynesian liquidity

trap. In the model, the low leverage arises because additional money has little force in stimulating additional capital investment during a period of general overcapacity. Instead, money is witheld in idle balances when profitable investment opportunities are scarce.

The source of liquidity trap behavior in Figure 4 is also consistent with the model of capital investment in the General Theory. In Chapter 13 of the General Theory, Keynes remarks:

> "If...we are tempted to assert money is the drink that stimulates the system to activity, we must remind ourselves that there may be several slips between the cup and the lip. For whilst an increase in the quantity of money may be expected, cet. par., to reduce the rate of interest, this will not happen if the liquidity preferences of the public are increasing more than the quantity of money; and whilst a decline in the rate of interest may be expected, cet. par., to increase the volume of investment, this will not happen if the schedule of the marginal efficiency of capital is falling more rapidly than the rate of interest...(p. 173)

In Figure 4, overexpansion of capital sharply depresses the perceived profitability of new investment (the marginal efficiency of capital), yielding low leverage of monetary stimulus until excess capacity depreciates.

Figure 5 carries the argument still one step further by showing model response to a monetary stimulus 5 times the size of that in Figure 4. As in Figure 4, curves for production of capital goods and labor in capital sector are superimposed for the base simulation (from Figure 3) and the new simulation with an aggressive monetary stimulus. Figure 5 exhibits more initial response than Figure 4 following advent of the monetary stimulus at year 26. Both production of capital goods and labor in capital sector rise by about 15% from year 26 to year 32. But a further look at the behavior indicates that the peak in production of capital goods is only deferred by about 6 years, so that the monetary stimulus does not induce a continually increased level of investment activity. Moreover, production of capital goods drops sharply following year 32 and bottoms out at the same point in time and at a lower value than in the simulation without monetary intervention. Similarly, labor in capital sector peaks later and at a

higher value but reaches a trough at the same time as before and at lower level, indicating higher unemployment than without the stimulus.

In Figure 5, following the monetary intervention, relatively easy money provides a greater incentive to order capital. Capacity expansion continues further than in the curve reproduced in Figure 3. But now the overcapacity that characterizes the peak in production of capital goods reaches even a higher level than without the stimulus. This overcapacity eventually makes further investment even less attractive and causes the decline in capital output to proceed from a higher peak and at a faster pace. Due to persistent excess capital which cannot be reduced as fast as labor can be cut back to alleviate excess production, unemployment actually

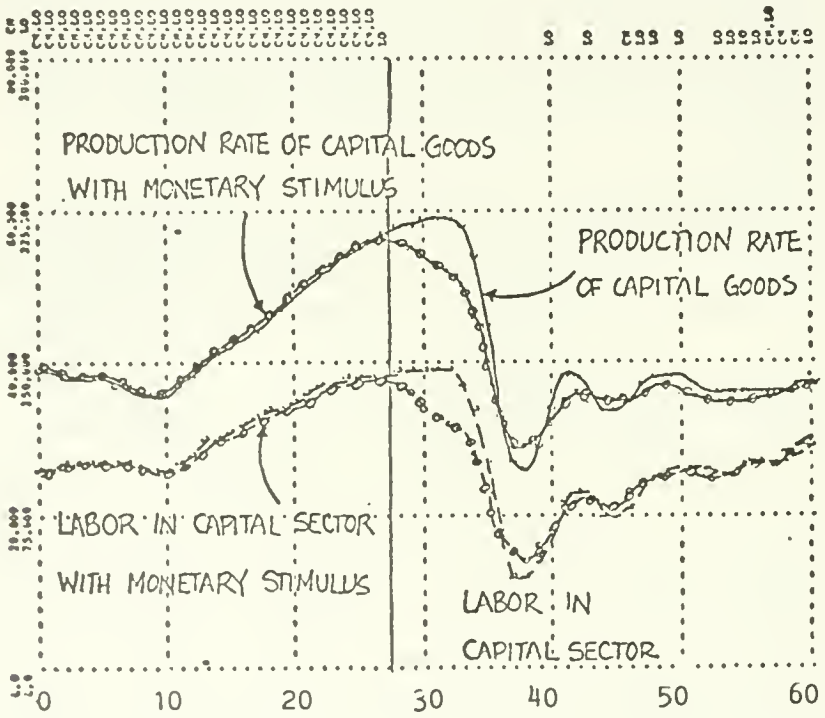

Figure 5. Initial impact of aggressive monetary stimulus followed by reversal

remains higher on the average following the drop in production.

Figure 5 suggests that even aggressive monetary intervention can do little to correct excess capital plant. Once excess capacity develops, the forces that previously led to aggressive expansion are almost played

out. Efforts to prolong high investment can produce even more excess capital plant and lead to a more pronouced readjustment later. The behavior is consistent with Keynes' comment in the Treatise quoted earlier regarding saturation of monetary policy influence in an investment downturn.

Ongoing work beyond that reported above provides some additional perspectives on liquidity trap behavior. Once production of capital goods overexpands, liquidity shortages can appear both on the part of producers and consumers. Shortage of liquidity on the part of households can arise as employment and wage rates reach a peak along with production of capital goods. In turn, inadequate liquidity tends to restrain purchases and thereby aggravate overcapacity conditions in industry. Inadequate liquidity in industry, and especially in capital sectors, can emerge as orders for capital goods and therefore revenues decline relative to interest expenses and other obligations. In the face of general liquidity shortages, expansion of money supply by the Federal Reserve may facilitate rebuilding of liquidity, but will tend to produce little investment and employment. These interactions are the subject of further research by the author.

IV. Conclusions

This paper has developed a microeconomic theory of liquidity trap behavior. The theory revolves around a set of forces that for a period of time promote cumulative expansion of capital formation, but eventually lead to overexpansion of capital production capacity and then into a situation where excess capacity strongly counteracts expansionary monetary policies.

The liquidity trap has been viewed skeptically by many economists. However, the skepticism may largely be a function of the weakly developed microeconomic basis for the liquidity trap in the literature. The theory presented here is intended to provide a first step towards a behavioral explanation of the liquidity trap.

But a second impediment to serious consideration by economists of the liquidity trap phenomenon besides absence of a coherent theory has been lack of demonstration of the relevance of the behavior to real economic events. Full demonstration of such relevance is beyond the scope of this paper. However, events in economic history of the 1920s and the 1930s provide some evidence that the 1930s may have been characterized by severe overexpansion of capital-producing sectors of the economy that caused severe diminution of investment opportunities and consequent strong recessionary pressures that would resist monetary cures. Gordon (1974) describes the historical record as follows:

> "The outstanding fact about the movement of total capital formation in this decade [the 1920s] is the high level reached by 1923 and the maintenance of this level for seven years. We have here a prolonged period of high-level investment in producer durable goods and contruction...it is significant that both producer and consumer durables formed a larger fraction of the GNP during the 1920s than during any period before World War I....
>
> The investment boom and the rise in consumption during the 1920s were accompanied by a steady expansion of bank credit, the flotation of an enormous volume of new security issues, and a mounting tide a speculative fever....
>
> The consequences of these financial developments need no elaboration. One result was a good deal of investment that was not justified in terms of long-term profit possilbities. Capital goods that were created that were to "hang over the market" and discourage

> further investment for a decade after 1929....
>
> We can dispose of a number of hypotheses as to the major cause of the downturn in 1929. It was clearly not due to an encroachment of costs on profit....nor can the downturn be explained by monetary developments. The rise in interest rates was not great enough to discourage business borrowing....We have already seen that business had become increasingly independent of the banks, and commercial loans did not begin to decline until after the stock market crash....
>
> There remains the question: Why was the recovery of the 1930s so slow and halting in the United States, and why did it stop so far short of full employment? We have seen that the trouble lay primarily in the lack of inducement to invest. Even with abnormally low interest rates, the economy was unable to generate a volume of investment high enough...to raise aggregate demand to the full employment level.

One area for further investigation, therefore, is to analyze relevance of the capital investment theory of the liquidity trap presented here to the Great Depression of the 1930s. The overinvestment theory runs counter to the dominant economic cycle theory, represented by Friedman and Schwartz (1963) and others, that attributes the Great Depression primarily to overly restrictive monetary policy, with the implication that more expansive monetary policy would have exerted high leverage on overall economic activity. Clarification of these two viewpoints is important to the economic theory of major depressions.

The overinvestment theory of the liquidity trap should also be examined for its capacity to explain the weak worldwide investment environment that has prevailed since the 1974-5 recession. Many people see the cure to that weak investment environment as simply a strong dose of monetary and fiscal policy. But some evidence exists that where such expansionary policy measures have been tried they have met with little success. For example, Kurt Richebacher of the Dresdner Bank has noted that a stagnant investment environment in Western Germany has persisted despite a federal deficit that is twice as large in relation to GNP as that prevailing in the United States (4.5 percent versus 2.3 percent) and despite a higher rate of monetary expansion. Developing explanations of such behavior is an important area for futher research. The behavior described by Richebacher would imply that "the policy multipliers" of

monetary and fiscal action can change substantially as the economic environment shifts, so that multiplier values derived from past time series evidence may have little relevance to present economic policy making.

On a more theoretical plane, a major area for further investigation is to integrate the overinvestment theory here that revolves around demand and supply for physical capital goods with a detailed model of demand and supply for financial capital. In particular, the "financial instability hypothesis" developed in Minsky (1975, 1978) appears to complement the capital overinvestment theory. Combining the best elements of the two theories in a single model may provide a powerful mechanism for integrating separate, and often divergent, literatures on real versus financial influences on capital investment behavior.

BIBLIOGRAPHY

Bischoff, C.W. 1971. Business Investment in the 1970s: A Comparison of Models, Brookings Papers on Economic Activity

Clark, J.M. 1917. Business Acceleration and the Law of Demand: A Technical Factor in Economic Cycles, Journal of Political Economy, March

Chenery, H.B. 1952. Overcapacity and the Acceleration Principle, Econometrica, January

Dornbush, R. and S. Fischer 1978. Macroeconomics, New York, McGraw-Hill

Friedman, M. and A.P. Schwartz 1963. A Monetary History of the United States, Princeton, Princeton University Press

Gordon, R.A., 1961. Business Fluctuations, New York, Harper & Row

Johnson, H.G. 1961. The General Theory after 25 Years, American Economic Review

Jorgensen, D.W., J. Hunter, and M.I. Nadiri 1970. A Comparison of Alternative Econometric Models of Quarterly Investment Behavior, Econometrica, March

Jorgensen, D.W. and C. Siebert 1968. A Comparison of Alternative Theories of Corporate Investment Behavior, American Economic Review, September

Keynes, J.M. 1930. A Treatise on Money, New York, Harcourt and Brace.

Keynes, J.M. 1936. The General Theory of Employment, Interest, and Money. New York, Harcourt, Brace.

Keynes, J.M. 1937. The General Theory of Employment, Quarterly Journal of Economics, vol. 51.

Keynes, J.M. 1937a. Alternative Theories of the Rate of Interest, Economic Journal, vol. 47.

Koyck, L. M., 1954. Distributed Lags and Investment Analysis, Amsterdam, North-Holland Publishing Co.

Leijonhufvud, A. 1968. On Keynsian Economics and the Economics of Keynes, New York, Oxford University Press.

Lerner, A.P. 1961. Comment [on Johnson 1961], American Economic Review

Mack, R.P. 1967. Information, Expectation, and Inventory Fluctuation, New York, National Bureau of Economic Research

Mass, N.J. 1978. Capital Formation: A Crisis in Which Direction?, System Dynamics Group Working Paper D-2703-5, Cambridge, Mass.

Minsky, H.D. 1975. John Maynard Keynes, New York, Columbia University Press.

Minsky, H.D. 1978. The Financial Instability Hypothesis: A Restatement, presented at Western Social Science Association, 1978 meeting, Denver, Colorado.

Mitchell, T.W. 1923. Competitive Illusion as a Cause of Business Cycles, Quarterly Journal of Economics, August

Mitchell, W.C. 1927. Business Cycles--The Problem and Its Setting, New York, National Bureau of Economic Research

Micthell, W.C. 1941. Business Cycles and Their Causes, Berkeley, University of California Press

Robertson, B. 1940. Essays in Monetary Theory, London, P.S. King and Son.

Senge, P.M. 1978. The System Dynamics National Model Investment Function: A Comparison to the Neoclassical Investment Function, M.I.T. Ph. D. thesis, Cambridge, Mass.

Stanback, T.M., Jr. 1961. Postwar Cycles in Manufacturers' Inventories, Princeton, NJ, Princeton University Press

Wright, D.M. 1961. Comment [on Johnson 1961], American Economic Review

Zarnowitz, V. ed. 1972. The Business Cycle Today, New York, National Bureau of Economic Research